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THE MASSASAUGA AND ITS HABITS.

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NOTWITHSTANDING the almost universal dislike entertained by people for snakes, the horror even that the sight of them excites in some minds, and the low value generally placed on ophidian intelligence, the more unprejudiced attention that has been bestowed by a few persons on these animals within recent years has shown that there is, after all, much to be said in their favor. Their lithe forms, their active and graceful movements, and their frequently brilliant and variegated colors, would at all times have rendered them attractive objects had not the possession of these qualities been more than offset by the actual or supposed possession of others of a disagreeable or dangerous nature. A closer acquaintance with snakes dispels many of our old prejudices against them, as being animals degraded in structure, malicious in disposition, and as laboring under a special curse; and presents them to us as possessors of many singular adaptations to their environment, many sagacious habits relating to the preservation of themselves and of their young, and sometimes of considerable conjugal and parental affection; and, by inference, enjoying as much of the favor of Heaven as most animals. That very interesting work by Miss C. C. Hopley, entitled "Snakes; Curiosities and Wonders of Serpent Life," will doubtless do much to remove unreasonable prepossessions against these persecuted animals, and to awaken greater interest in them and their ways. When we have learned more about

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them, we may discover that He who "spake with *authority*" also spake as having knowledge of nature when He used the words, "as wise as a serpent."

At present far too little is known concerning the life-history of the great majority of our snakes. Of the breeding habits of many species and large groups of species we know little or nothing, and it is to be desired therefore that accurate observations should be made and reported. I hope in this paper to contribute something to the knowledge of the Prairie Rattlesnake, or Massasauga (*Caudisona tergemina*).

This venomous serpent ranges from Ohio to Utah. Towards the north it extends into Michigan, Wisconsin, and to the Yellowstone River. It has also been found in Georgia and in Mississippi; but it appears to be replaced in the greater part of the South by *Caudisona miliaria*. Its general color above is from gray to brown, with seven rows of dark spots which have a light margin. The belly is mottled with black and yellowish. In Ohio and some parts of Indiana black specimens are sometimes found, and to these the name "Black Massasauga" has been given. Specimens of these were described by Holbrook as *Crotalophorus kirtlandii* in honor of Dr. J. P. Kirtland, their discoverer. Professor S. F. Baird also regarded this form as a distinct species; but of late herpetologists are not inclined to consider it as worthy of even varietal distinction. That the spotted form is ever found in wooded lands I do not know; but the black form, both in Ohio and Indiana, lives in swampy lands which are overgrown with brush, weeds, and coarse grass, and not on the open prairies.

Some of Dr. Kirtland's statements concerning the Black Massasauga are, I think, to be taken with some grains of allowance. With reference to its bite he has, it appears, asserted that its virulence is scarcely greater than that of the sting of a hornet. There are probably no differences, as respects virulence, between this snake and the more common pale and spotted form living on the open prairies, and where the latter is best known it is much feared; and certainly the effects of its bite on the large domestic animals are very serious. The members of this species are probably as poisonous as are individuals of equal size belonging to any of the other species; and since specimens of the Massasauga frequently attain a length of two feet and more, one of

them would probably be equivalent in virulence to a whole colony of hornets.

Some twenty-five or thirty years ago this species was excessively abundant on the then sparsely-settled prairies of Northern Illinois; and among the farmers' boys of that day the slaughter of these snakes furnished a means for establishing a reputation for courage and enterprise. As more and more of the land came under cultivation, these serpents rapidly disappeared; so that, where they were once so numerous, they have scarcely been seen for perhaps twenty years. The reasons for this rapid extinction are, I think, not clear. Men, hogs, deer, and the larger wild fowl are regarded as the principal enemies of the Crotalidæ. Of course every man and boy attacked and killed every rattlesnake that was seen; but so likewise they did with every harmless snake; and the species of the latter have not usually suffered to the same extent as the rattlesnakes.

The members of the hog family are the foes of the venomous, and perhaps also of the non-venomous, serpents; but in the districts to which I refer the production of wheat, oats, and corn was at that time so exclusively pursued that but few hogs were raised, and these few were kept shut up in close pens, and thus prevented from exercising any influence on the reptilian fauna. Of their other enemies, the deer were early exterminated, and the native large wild birds, which may possibly have been addicted to devouring the young snakes, were by the "murdering guns" soon greatly reduced in numbers. That the mere disturbance of the soil in cultivation would be more prejudicial to the welfare of the rattlesnakes than to that of other species of serpents we do not know. Possibly, being heavy and clumsy animals, they would find it difficult to move about over cultivated fields and pursue there their vocation, and would abandon them. In this connection it might be profitable to study the influence of similar changes of environment on the Heterodons. It appears to me quite probable, however, that as the country became more thickly settled, the rattlesnakes were deprived to a considerable extent of their opportunities for securing food. In primitive times the prairies were the breeding-grounds of great numbers of prairie-hens (*Cupidonia cupido*) and other ground-nesting birds, whose young and possibly also eggs contributed largely to the support of the various species of snakes. The cul-

tivation of the land interfered greatly with the breeding of these birds, and the prairie-hens were soon thinned out by the hunters, and thus the resources of the venomous snakes were greatly reduced.

The assertion that the sound of the rattle of the Massasauga is so feeble that it is scarcely audible is certainly incorrect. From experience I know that it can be heard at a distance of several feet.

The purpose of the rattle of the Crotalidæ has exercised the ingenuity of many minds and called forth many conjectures. The old notion that it was intended as a means of preserving man from the bite of the snake does not meet the requirements of the case. The organs of animals and plants are designed for the benefit of their possessors, and not for the benefit of some other organism. The somewhat close resemblance of the whirr of the rattle to the song of some grasshoppers has suggested to some one the idea that it is produced in order to lure within reach of the snake some of the grasshopper-eating birds. This hypothesis seems to lack the necessary basis of observation. No one probably has yet heard hungry rattlesnakes in imprisonment sounding the rattle in the vain hope of securing food. Nor is there any more evidence to prove that it is of use in bringing the sexes together. The anal scent-glands would seem to be far more efficient for that purpose. The sexes once together, it is quite possible that their emotions may be expressed by the low humming of the rattle that has been observed. Mr. Darwin concluded that the crepitation produced by the organ is used to frighten away the many birds and beasts that are liable to attack the snake. The means adopted to produce this result ought, then, to be regarded as a signal failure, for no man, or hog, or deer, or ravenous bird, that had resolved to attack a serpent, would probably be deterred therefrom by such impotent demonstrations. If the inspiration of fear were their purpose, we might expect the serpent to elevate itself like the cobra, or make other threatening movements, whereas the rattlesnake lies almost motionless in a coil, meanwhile sounding its rattle, a model of repose born of a consciousness of the possession of reserve power.

The opinion that is generally held that the rattle is sounded as a warning to some enemy which the snake has reason to fear is, I think, the correct one, notwithstanding all that has been

said against it. Dr. Elliott Coues has concluded that "the actual result of its use as a menace in self-defence is the reverse of beneficial to the serpent, since the sound serves to direct and provoke attack from all the enemies which the animal has reason to fear." We are led to wonder how the rattlesnakes have been enabled to maintain themselves in the struggle for existence. In spite of the possession of this organ, thus pronounced to be of no use to them, and constantly betraying them into the hands of their enemies, the rattlesnakes have succeeded in diffusing themselves over most of the western hemisphere, in adapting themselves to many varied conditions, and in producing many species and an excessive number of individuals. On the other hand, the Copperheads and Cottonmouths, in possession of all the advantages enjoyed by the rattlesnakes in the way of poison-glands and fangs and relieved of the so-called disadvantage of the rattle, have neither extended their range so widely, nor developed into so many species, nor perhaps become so abundant in individuals.

Nothing can be more certain than the fact that the rattle is used chiefly when the snake is alarmed or angry. The whirr then serves to warn an approaching enemy that it is coming into collision with a rattlesnake, and not with something else. This is done for the special benefit of the snake. It is not benevolent, but intensely selfish. It is evidently extremely solicitous for its precious store of poison and its battery of fangs, without which it would fare slenderly in its endeavors to get a living; and if it can induce its antagonist to withdraw, the snake will have saved its stores and have escaped other possible results of a pitched battle. This warning must have been very efficient with most animals. In the eastern United States there were no native species of the hog tribe to devour snakes. To what extent deer are accustomed to destroy rattlesnakes we do not know. It appears to me that the rattlesnakes had more to fear from the numerous buffaloes that roamed over the greater part of the continent than from any animals that made direct war on them. The serpents must have been in frequent danger of being trodden upon by these, and to have attempted a war on a herd of large animals would have been useless. But through the simple device of sounding the rattle, each animal as it approached would be warned of the presence of the snake and would probably be induced to give it abundant

space. Thus the poison might be reserved for such as could not take a hint. Doubtless, too, by this means, the snake was saved from many a rude tread by bear, or wolf, or panther, that to the serpent would at least have been very unpleasant, and might have involved it in a fight in which it had everything to lose and nothing to gain.

Within the past few weeks some specimens of the Massasauga have come under my notice, whose history may throw some light on the breeding habits of this species, as well as on some other matters that have been discussed. These specimens belonged to the black variety, and were captured in the northern part of Hendricks County, Indiana, by Mr. M. B. Harvey, of Rainstown. This gentleman's truthfulness is testified to by friends in whom I have complete confidence, and his statements are made with such sincerity and carefulness that I have no hesitation whatever in accepting them.

The specimens, two in number, one about two feet long, the other somewhat less, both dull black without trace of spots above, were captured about the 1st of last August and kept in close confinement. They were found in an old swampy clearing that was somewhat overgrown with brush. About the 1st of September they both brought forth living young,—one five and the other six,—the two broods appearing within thirty or forty hours of each other. Two of the young died when about three weeks old; the others are still alive (January 28) and in apparent health. Neither the parents since their capture nor the young since their birth had had, up to January 1, anything either to eat or to drink. About the latter date the corner of the box containing them was put into a vessel of water, and one old one and one young one partook. With this exception none have had either food or water up to the present time. Mr. Harvey states that at first the young were but three or four inches long. Some of them are now at least ten inches long, as I know from observation. Others are somewhat smaller. How can this growth have been made? It is possible, I think, that the gentleman has been somewhat mistaken as to the original size; or some of them may have been that small, while others not specially observed were larger. A specimen of the light-colored variety in my possession, which was taken from the mother but which had the fangs developed, measures, when outstretched, five and a

half inches. It was hardened in alcohol while spirally twisted within the egg-membranes, and would when born probably have been somewhat longer. However, it is quite evident that Mr. Harvey's specimens have made some growth. Having at hand another alcoholic specimen, seven and a half inches long, which probably had not long been born at the time of its capture, and observing in the posterior portion of its body a hard lump, it occurred to me to open the abdomen and see what the young snake had eaten. The whole intestine was empty, and the hard lump consisted of an elongated mass of egg-yolk two and a half inches long and about three-eighths of an inch in diameter. On such a store of highly-nutritious materials doubtless the young are accustomed to subsist and grow until they are able to capture their own food.

The question whether or not the young ever enter the mother's mouth and stomach for refuge from danger and are permitted to come forth again has been much discussed. It would seem that the results of Mr. Goode's inquiries ought to have settled the question, but there are still many sceptical persons. In the issue of *Nature* for December 24, 1885, a writer, in discussing the case of *Pelias berus*, suggests as an explanation of what has been observed, that possibly the young in their fright, against the mother's will, rush into her mouth as they would into any other opening that might present itself; and that once having entered the stomach they may either never leave it again alive, or they may act there as an emetic and be violently ejected! Now, Mr. Harvey states that his young snakes were accustomed, from their birth up to the time they were a month old, to pass freely into and out of the mothers' mouths. He does not know that they were ever all in the mothers' stomachs at the same moment, but sometimes three or four of them would be missing at once. Sometimes one would be seen going down the throat while another was coming out. Occasionally one might be seen with his head sticking out of one corner of the mother's mouth like a cigar, while in the other corner would be another's head or possibly tail. In describing the mother's movements, Mr. Harvey says, in a letter, that "the mother would sometimes lay her lower jaw on the floor, raise her upper jaw and with it her entire backbone, thus adjusting herself for them to play in and out. . . . They seemed to go in the full length of the stomach." When the

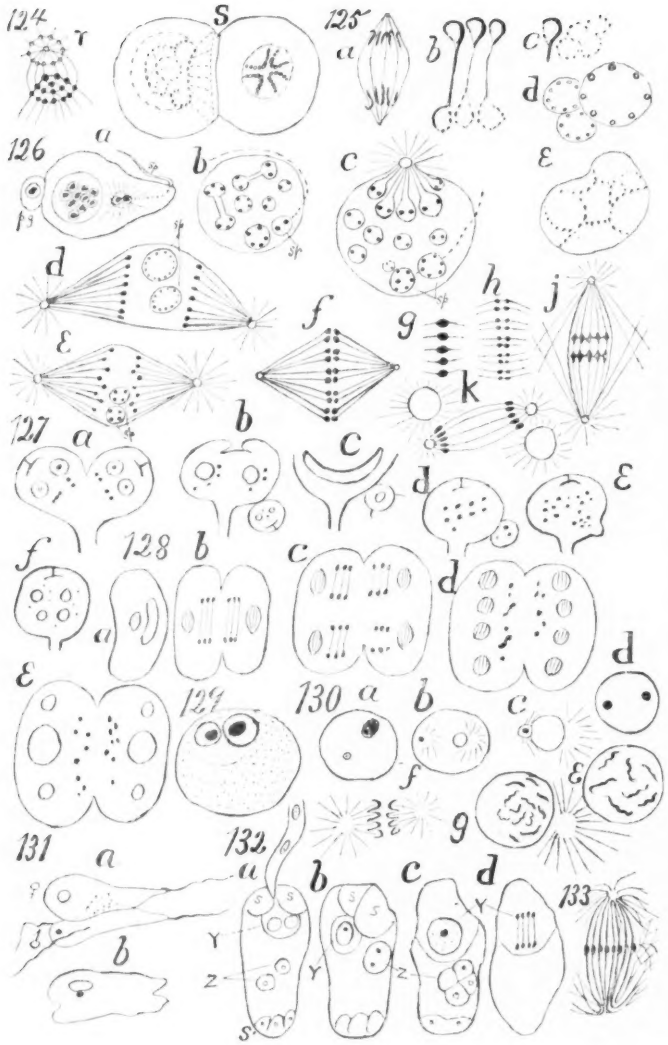
young were about a month old they sloughed their skins, and after that event they were never observed to enter the mother's mouth, though they may have done so.

The maternal instinct must be very strong in these reptiles, usually regarded as so low in intelligence and so unfeeling, when they will for weeks and months endure hunger and thirst and still continue to care for their young. One might readily suppose that if the young ever entered the mother's stomach, the temptation would, under the circumstances, be almost irresistible for her to keep them there. When I first saw these specimens, about January 1, the old and most of the young were coiled up together as if for the purpose of keeping themselves warm. The heads of all the young ones were lying out on top of the coils, as if they were as desirous of seeing what was going on as are other young folks. One little one, however, was away from the others on the bottom of the box. One of the mothers appeared to take great interest in it, and kept rubbing it with her head and pushing it gently about with her snout. Mr. Harvey states that the mothers have been accustomed in various ways to show their affection for their young. "The mother would raise her head, turn it about and look over the young, place her nose against them, push them about, and pull them to her side."

The old ones have not shed their outer skins since their captivity began. Since they appear to change their dress twice a year, it is quite likely that this was accomplished just before they were captured. One young one who was watched got rid of his cuticle in about twenty minutes from the time that it was seen to be loose on his head.

Most of the young are quite dark in color, but all have plain indications of the rows of spots usually found in the species, and one has the ground color so pale that it closely resembles the young of the specimens found on the open prairies.

PLATE XI.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THE SIGNIFICANCE OF SEX.

BY JULIUS NELSON.

(Concluded from page 162.)

PLATE XI.

FIG. 125, *a–e*. From the segmenting egg of the *Axolotl*—Bellonci, Arch. Italiennes de Biol., vi.—Shows how the knäuel reticulum is formed from the loops. The loops in this case are hook-shaped, or almost straight rods, the end of the segment which first reaches the pole swells out and the chromatin breaks up into microsomata, the whole segment is thus transformed into a vesicle containing peripheral microsomata. These vesicles fuse as in *c*, *d*, *e*, and the microsomata become arranged in rows, which thus form a reticulating filament.

FIG. 126, *a–k*. Fertilization of ovum of *Arion empiricorum*—Platner, A. m. A., xxvii.—In *a* we see the polar globule (*pg*) and the spermatozoon (*sp*), whose head and neck have penetrated into the egg, but left the tail free. The head consists of a hyaline material holding two karyosomata. As usual astral rays surround it. The germinal vesicle contains many karyosomata, each with a hyaline envelope. The head of the spermatozoon at last becomes included in the germinal vesicle. In *b* we see the karyosomata have broken up into many microsomata arranged at the periphery of each hyaline vesicle, they fuse, so that for the most part, as in *c*, each shall contain two microsomata at opposite sides. But the hyaline vesicles themselves fuse (or divide?) as indicated by the dumb-bell forms in *b*. The hyaline mass of the male pronucleus divides, so each half has a karyosoma, and the latter passes through the same stages of segmentation and fusion as the female karyosoma, except that each vesicle has finally four microsomata instead of two (*c*, *d*, *e sp*). [Only the germinal vesicle or its contents are shown in all figures except *a*.] On the side of the germinal vesicle towards the centre of the egg there arises an aster (*c*), and some of the hyaline vesicles become club-shaped and send out stalks and put themselves into connection with it, the membrane of the germinal vesicle disappearing at this point. In *d* a second aster has arisen, also near the first, so that the two are not at first opposite each other, but become so more and more by swinging around into a right line, and as they do so the germinal vesicle sinks towards the interior of the egg; the remaining microsomata, like the first lot, now become connected with this aster, except that the male karyosomata are behindhand (*d*, *e*), but finally these also join. Meanwhile the microsomata become regularly disposed in an equatorial plate and grouped in fours, each pair of a four being united by a spindle-fibre to its own pole (*f*). Then each group of four microsomata fuse to form one karyosoma on each fibre (*g*), and again segmenting into four (*h*), they separate, leaving connecting fibrils between them. As the microsomata move polewards there is a stage, as usual, where they seem to fuse laterally (*j*). In *k* we see the spindle turned out of its position, leaving the two large polar asters *in situ*, but still possessing little ones of its own. Such is the history of the first segmentation after fertilization. By comparing it on the one side with Fig. 124, and on the other with Fig. 127, it is seen to form a connecting link.

FIG. 127, *a–f*. A case of conjugation with *Vorticella microstomum*—Engelmann, M. J., i.—When division or budding takes place the nucleus stretches into the bud and is segmented *a.f.* These buds are the microgonidia or males, and may suffer

segmentation like sperm mother-cells before being set free. The mother from which they budded is the macrogonidium, and is itself soon fertilized by a microgonidium, which is the child of another macrogonidium. *c* shows the first step in this conjugation. The nucleus, both in the macro- and the micro-individual, segments up into bits, smaller and smaller, and the microgonidium being absorbed, its microsomata are added to the more numerous microsomata of the female. Then there is gradual fusion until the single nucleus is reconstituted. Before this happens there may be division and budding, as in *a* and *b*. An exactly similar series of phenomena is described for *Epistylis plicatilis*.

FIG. 128, *a–e*. Conjugation of *Paramœcium*—Enc. Brit., "Protozoa."—This illustrates "temporary conjugation." *a* is a normal individual; *b*, two united for sexual ends. The nucleus and paranucleus divide successively, the former into many, the latter into four bits, and then they fuse again, only partially completed in *e*; but now the old nucleus becomes the new paranucleus, and the former paranucleus takes on the functions of the nucleus. The individuals separate and continue asexual division. This is probably an incomplete account of what happens. There is much controversy about this ill-understood process, but we must assume that there is mutual interchange of microsomata between the two individuals in harmony with some observations, and thus bring this process into line with what we know happens in all other cases of fertilization. (See text for further discussion.)

FIG. 129. Fertilization of egg of Bat—Van Beneden and Julin, A. B., i.—The two pronuclei are seen each in a vesicle lying in a clear space in the vitellus and in proximity to each other.

FIG. 130, *a–g*. Fertilization of ovum of *Sphærechinus brevispinosus*—Flemming, A. m. A., xx.—In *a* we see a large female pronucleus, and a smaller male pronucleus in the egg. In *b* each has been crowned by an aster. The male pronucleus now moves towards and fuses with the female pronucleus (*c*). The chromatin of the male pronucleus may split as in *d*, but soon all the chromatin of the fertilized nucleus is transformed into a segmented "skein" (*e*). At the same time polar asters appear, whose rays drive the segments to the equator (*f*), where they arrange themselves in a regular plate, split, and pass to the poles, there constituting the daughter-nuclei, one of which is shown at *g*, still crowned by its aster.

FIG. 131, *a–b*. "Genetic blending" of *Dallingeria drysdali*—J. R. M. S., April, 1886.—We may suppose the form with one flagellum, large nucleus, and granular zone to be female; then the form with three flagella and small nucleus is male. Both nuclei and bodies fuse to one individual, and then the nucleus is dissolved, and the cell is encysted, finally to burst, as myriads of spores, scarce visible under fifteen thousand diameters magnification.

FIG. 132, *a–d*. Fertilization phenomena in *Orchis latifolia*—Strasburger, Befruchtungs Vorgang bei den Phanerogamen, Jena, 1884; see also Jen. Zeits., xi.—Two sorts of nuclei, "germinative" and "vegetative," are found in the pollen-grain and tube, and these may multiply by karyokinesis. The former alone act as male pronuclei, and where there is more than one, the first one to make its way to the egg does the fertilizing; the others then are passive. The nucleus of the embryo-sac dividing sends each daughter-nucleus to its own pole, and there each undergoes division twice, producing four nuclei at each end of the sac. Then one of these from each end meet and conjugate in the centre (*z*) to form the mother-cell of the endosperm. Two of the remaining ones at the upper end (where the pollen tube enters) form the "synergids" (*s*) supposed to function in secreting a fluid attractive to the pollen-tube; the fourth becomes the ovum or female pronucleus (*y*). The three nu-

clei at the other end (s') are the antipodal cells. In *a* the male pronucleus has entered the ovum. In *b* the two have fused, but the nucleoli are still separate. In *c* the nucleoli are one; and in *d* the first segmentation spindle of the embryo is formed.

FIG. 133. A segmentation spindle from the egg of *Aulostomum gulo*—Nussbaum, A. m. A., xxvi.—To show the direct continuity of spindle-fibres with the yelk reticulum.

(*d*) FERTILIZATION.

FERTILIZATION, fecundation, copulation, conjugation, zygosis, are some of the terms used indiscriminately when referring to the fusion of sexual elements. We may refer to the *fusion* of nuclei, or of cells; or simply to the *apposition* of cells, or of individuals for sexual purposes. We shall use the term *conjugation* always in the former sense and *copulation* always in the latter. Thus we shall use the term *copulation* where other writers say "temporary conjugation." Conjugation of cells when not followed by conjugation of the nuclei produces *plasmodia;* we might use the term *zygosis* when fusion of the nuclei is involved. *Polyspermy* is where more than one male cell fuses with a female cell; and *superfecundation* implies, or should imply, the conjugation of more than two nuclei to form one *zygote.* We need one term more, and that is where, in polyspermy, the female nucleus segments by stenosis to furnish a partner for each of the male nuclei. For this case we would suggest the term *multifecundation.*

The modern theory of fertilization dates from the birth of the cell theory, when Kölliker extended its scope by advancing the view that the spermatozoon is a cell, and that it fertilizes the egg by a fusion with its substance, as against the theory that it was the fluid portion of the semen which holds the impregnating power. This view was not established until 1847, although Barry had seen the spermatozoon penetrate the ovum in 1843. It was now possible to compare fertilization with the conjugation which successive years of study continued to discover in the different groups of plants and animals, but with this line of development we are not here concerned.

In 1827, Baer described as *maturation* of the ovum the changes which the egg nucleus suffers, and Purkinje three years later named this nucleus the *germinal vesicle*, because it bursts and lets out its "generating lymph" through the germ. Attention was first called to the polar globules by Dumortier, and Müller named them *direction corpuscles* in 1848, because he thought they fixed

the plane of cleavage. It was in 1862 that Robin gave them the name they now usually bear.

In 1842, Bischoff saw the germinal vesicle expelled from the egg during maturation, and this was confirmed by other observers, and thus the idea that the polar globules were the extruded germinal vesicle was gradually established.

In 1853, Keber discovered the micropyle, and the theory o actual penetration of spermatozoa into the egg thus received more favor, speculations concerning the functions of the spermatozoon became more numerous. Bischoff held the katalytic theory, by which molecular motion was supposed imparted to the egg through the spermatozoon. Meissner thought it was a nutriment, others thought it served to help maturation, and thus for a long time the formation of polar globules was supposed to depend on fertilization. The independence of these phenomena was shown in 1875 by Hertwig.

The penetration of more than one spermatozoon was seen by several observers, and it was only gradually that the idea gained ground that normally but one spermatozoon enters the egg. Perez thought, in 1879, that there may be degrees of parthenogenesis, so that if this is strong in tendency, it does not take as many spermatozoa to saturate the ovum as if weak.

The next step was the discovery of the sexual pronuclei. The male pronucleus (so termed by Fol) was first seen by Weil in 1873, but its direct morphological connection with the head of a spermatozoon was first established by Hertwig in 1875. Hertwig also showed that the whole germinal vesicle was not extruded in the polar globules, but that the germinal dot remained to be transformed into the female pronucleus, which fused with the male pronucleus. Auerbach had seen these pronuclei fuse, but supposed they originated in opposite poles of the egg, and by uniting, the characters of the different hemispheres of the egg would be mixed. Beneden and Bütschli practically saw the same thing later, but likewise derived these bodies by endogenous formation. Fol was, however, successful in seeing the female pronucleus derived from the amphiaster which extruded the polar globule; but it remained for Hertwig, in 1877, to show that the polar bodies arise by a true karyokinetic division of the egg-nucleus, and are thus the homologues of the female pronucleus. Bütschli and Giard arrived at this result independently.

Then Whitmann was enabled to give what we consider as the true theory of the polar globules,—viz., that they represent an asexual generation of cells that once were functional.[1] Beneden, Minot, and Balfour carried this view so far as to say that the polar globules are male cells. Thus, that every cell is hermaphrodite, having male and female plasmas, and that the cells become sexed by extruding one of these plasmas. It can then no longer develop until it has fused with a cell containing plasma opposite in character to itself. The absence of polar globules in any instance does not disprove the theory, for this plasm may be gotten rid of in many different ways. But this theory has lately received its death-blow by the discovery of polar globules in parthenogenetic ova. Strasburger has modified the theory by his idea that the nucleo-hyaloplasm is primary idioplasm, while the cytohyaloplasm is secondary; the former is conservative, the latter is adaptive. Cell phenomena are due to a dynamic interaction of the two. Two nuclei may be alike, but because the cytoplasms differ the cells will develop in a different manner. Cells become sexually mature, therefore, by getting rid, by division or any other way, of certain constituents in the cytoplasm.[2] Weismann says that these constituents are histogenic plasm,—*i.e.*, plasm which belongs to the cell as a cell,—and when this is lost then the plasm, which represents the generation of tissue-cells to come from the segmenting egg, may develop. A view similar in some respects was advocated by Robin in 1875.

It is strange how many different bodies, having not the slightest homology, have been appealed to to prove the sexual nature of protoplasm. Every sort of paranucleus has been worked into line with this theory. We have already adverted to the fact that paranuclei are themselves very different bodies. Thus, in Fig. 49, Gaule's paranucleus can be homologous only with the germinal dot of the (parthenogenetic) ovum; for from it the new cell develops, while the old nucleus goes to the ground. Besides paranuclei other things have been supposed to represent the lost sexed protoplasm, such as canal-cells, perivitelline excretions,

[1] Bütschli said the polar globules are to be considered as the first stages of development due to fecundation, rather than due to maturation.

[2] The idea of Fol is that certain substances injurious to further development must be excreted. This is only a general statement of the fact that cells must accomplish a certain cycle of work before they are sexually mature, most commonly a certain number of divisions.

synergid-cells, follicle-cells, nutritive cells, seminal granules, "remains" ("Rest") of protoplasm in spore formations, and, in fact, any sort of excretion and secretion. Trouble arises in explaining cases where more than one of these modes coexist. Thus, Sabatier holds that in gametogenesis one cell buds off a number of cells, which become nutritive to the mother-cell, in the ovary; while in the testes the daughter-cells develop to spermatozoa at the expense of the mother-cell. Such a theory as this cannot possibly be universally applied, and does not explain polar globules. Our knowledge of sex has developed by two steps more. Beneden showed in ascaris that the two pronuclei are just alike, each containing two loops that are placed in order in one equatorial plate in the zygote, and split as in ordinary karyokinesis, to furnish the two daughter-nuclei. (See Fig. 124, *l–o.*) In the latter the four loops reappear as a result of the process of reconstruction, so that Beneden thought that each daughter-nucleus had still two male and two female loops; and thus every cell of the body may be considered hermaphrodite, having the chromatins of the two sexes in morphologically distinct structures; and finally, when any cell becomes sexually mature, all that happens is a cell-division at right angles to the ordinary cell-division, thus separating the male from the female chromatin. But this theory is very faulty, for in the first place the phenomena of karyokinesis have as one object the mixture of the chromatins, and we know that this is accomplished in one phase or other somewhere between two successive divisions. Then, secondly, the chromatin derived from the spermatozoon possesses the characters of its ancestry, both male and female; if this be lost the characters which fertilization has bestowed are lost; and as this loss occurs with every generation, how could there ever be an accumulation of characters?[1] Only through the idea that chromatin is sexed can such grave errors as this arise. Platner (see Fig. 126) furnished an important contribution when he showed that in Arion the number of microsomata derived from the male pronucleus is less than a fourth as great as that of the microsomata in the female pronucleus. Thus the two pronuclei bear the relation of

[1] Strasburger holds that the contributions of the ancestors in each fertilization remain distinct in different parts of the mitom. Roux, in a somewhat analogous way, thinks that each portion of the egg-plasm corresponds with a definite portion of the soma that develops from the egg.

macrogonidia and microgonidia to each other. In Limax the microsomata are approximately equal in number in the two pronuclei; and as the result, so far as fertilization is concerned, is the same in the two animals, we must believe that the pronuclei need not be morphologically equal. It has been said that the two parents furnish equal contributions of hereditary characters because the chromatin is alike in amount in the two pronuclei. But this assumes that quality depends on quantity. We cannot accept this notion. We believe the quality of the chromatin inheres in the nature of each gemmule, that the gemmules are nearly alike, and that the quantity of chromatin may readily be increased by the multiplication of the gemmules. Such multiplication may take place in the male pronucleus before fusion because of the nutritive conditions furnished by the yelk. Even if it did not increase in this way, it might happen that the reproductive vigor of the fertilizing gemmules is so great that during ontogeny they would at last outnumber the ovum gemmules. We do not know whether characters are realized in proportion to the number of the gemmules, or whether it depends on the strength of the gemmules, or, again, on some dynamic influence reciprocally acting between the gemmules. In the last supposition we might have each gemmule possessing a system of vibrations whose wave-form could be slightly altered by the proximity of differing systems; and that, finally, equilibrium being established, it would require a new fertilization to introduce a new variation. It would also be intelligible how gametes may develop parthenogenetically before fusion is accomplished where only the preliminary steps to such end have been taken. Finally, such variation could be effected by other means than by fertilization.

Under the first supposition we could understand how, if cell-division should not succeed in separating the gemmules in due proportions, we might get cells that had a preponderance of gemmules of one ancestor, and the parts of the body developed from the offspring of these cells would present the characters of one parent to the exclusion of the other. But we defer the discussion of this point to the subject of heredity.

Strasburger claims that fertilization is effected by the fusion of similar parts in two cells, cytoplasm with cytoplasm, nucleus with nucleus, and nucleolus with nucleolus. But in phanerogams it is only nuclei that migrate from the pollen-tube to fuse with

the egg, and in many animals it is only the head of the spermatozoon that makes the male pronucleus, the greater part of the flagellum not even getting into the yelk, so that we are justified in believing that fertilization is essentially a phenomenon of the mixture of chromatins. We cannot speak even of the union of "half nuclei" to make a whole nucleus, nor say that the nuclei are morphologically alike, nor yet that they are the *complements of each other* in any way. That the sexual pronuclei are physiologically alike we may infer from the fact that the characters of both parents are equally well transmitted, and from the fact that we may get both male and female parthenogenesis, which latter statement receives its best support from the evidence afforded by polyspermy and by the behavior of unfertilized eggs. We know that, aside from differences in size or in locomotor organs and other secondary characters, gametæ may differ physiologically in this way: in one, which we usually call the male, or microgamete, there has been a greater number of cell-divisions than in the female gamete, but in the latter we may, by enforced parthenogenesis, secure just as many divisions, and so make the cells alike. But neither of the gametes have divided as many times as they can, for it is possible, though more difficult than with the ovum, to get male parthenogenesis. The offspring thus resulting are more sexed, have greater desire as well as need for fusion with other cells, especially cells that have not divided as much as themselves. Unless we give such cells easy conditions of life we reach a stage when they can no longer divide. Such facts as these, observed with spores and the protoorganisms, enable us to understand certain phenomena obtaining with fertilization in higher forms of life.

We should expect that in most cases the ovum would possess a tendency to segmentation, which is realized normally under conditions of easy nutrition in parthenogenetic development, but may be realized in a less degree with other eggs. As a matter of fact there have been a number of observations in widely different groups of animals that show a sort of irregular segmentation of unfertilized eggs. I have observed such cases not infrequently. Such segmentation is slow and irregular, and probably cannot proceed as far as normal segmentation. Von Jhering saw the female pronucleus form an amphiaster in unfertilized eggs. Schneider, Greeff, Oellacher, and others have reported development in un-

fertilized eggs. But this phenomenon has not received the attention it deserves.

In polyspermy we find that not only does the female nucleus form an amphiaster, either alone or by zygosis, with one male nucleus, but that the male nuclei left unconjugated also form amphiasters. This phenomenon was first studied by Fol, 1879, but Hertwig has just published an article fully illustrating these forms. If more than one spermatozoon conjugates with the female nucleus it develops a tetraster (sometimes a triaster), or a figure having a greater number of poles according to the number of spermatozoa fusing. It results that segmentation follows a series whose terms are multiples of the normal one. But this only when there are no free spermatozoa in the yelk, for in such a case each of these also segments and receives its bud of cytoplasm, thus making the segmentation of the egg irregular. When the nuclei fuse before the spindle is formed, the number of spindles seems to depend on the number of nuclei. (This may be doubtful, as the poles seem to be determined by asters independently arising in the yelk, which migrate to the nuclei and direct their transformation.) But the amphiasters and the more complex tetrasters, etc., may also unite among themselves, regardless of sex, by superposition of poles, thus building up complex figures that may be as regular as a dodecahedron. The result is the fusion of daughter-nuclei of diverse origins. It follows, therefore, *that the spermatic nuclei after one segmentation have an affinity for each other.* Hertwig found further, that the nuclei resulting from the segmentation of pronuclei became fused again, but whether there was subsequent division and normal development remains an obscure question. The male nuclei also form triasters and tetrasters which cannot be distinguished from those made by the female pronucleus; but it is possible that in these cases multifecundation has taken place. Besides Fol and Hertwig, polyspermy has been studied by Bergh and Horst, 1881, and by Strasburger in phanerogams; Salenka and Schneider report normal development as following polyspermy; but this subject also requires further study.

Another line of study has been followed by Hertwig. It is well known that certain nuclei which are not too closely nor too distantly related to each other are prepotent in zygosis above these others, and that the egg resists the entrance of foreign

spermatozoa. By letting the eggs lie a long time in impure water Hertwig has so weakened this resistance as to effect hybridization between forms not ordinarily capable of being thus hybridized. But as he got results closely similar with unfertilized eggs and also with eggs where polyspermy of its own species took place, and furthermore, that polyspermy ensued in these cases of enforced hybridization, we must be cautious in our inferences. To leave eggs a long time unfertilized, instead of developing the tendency to fuse with any partner, ought rather to develop the opposite or parthenogenetic tendency. Strasburger thinks superfecundation arises when the gametes are not sexually mature. But here again we have no thorough knowledge of the facts. Spermatozoa have also been seen to penetrate the polar globules, which is not remarkable, as we know that these are (when the first globule has divided again) the counterparts of the female pronucleus; but Hertwig found that the spermatozoa penetrate any globule of extruded yelk (whether it has a nucleus or not) when artificially pressed out through a rift in the egg membrane. Probably, then, the attraction of the spermatozoa is for the nutriment, or for the cytoplasm, and the nuclear attraction arises later in accordance with other laws.

We see from this survey that sex in its primary sense, as inhering in the nucleus, or perhaps in Strasburger's sense as due to a peculiar stimulus of the cytoplasm upon the unsexed nucleus, sex is not an absolute condition but admits of degrees, is, in fact, a want, a hunger, which the cells may experience in different degrees. How the mixture of different characters confers vigor to cell-division we cannot explain. Perhaps we would be more general if we said that fertilization consists in broadening cell-education. Hence parasites that are cells of one idea do not need it to any extent. At present we cannot see how it is possible to explain it on physical principles. It is, however, only a confession of ignorance to refer the problem of heredity to the domain of psychology; we have explained nothing in so doing.

The Protozoa.—Here the phenomena of fertilization are very varied. In the lower flagellates more than two cells may fuse; and polyzygosis has been observed also in Actinophrys and Arcella. We must, with Lankester, also place in this category the formation of plasmodia and of the *syzygies* of Sporozoa. In these plasmodia, especially when encystment occurs, there may

be a fusion of nuclei to a greater or a less extent before spore multiplication; and the same thing happens with multinucleated forms like Gastrostyla, Actinophrys, and Actinospherium. Multinucleated cells are not separated from plasmodia by any distinct line, for in Heliozoa, Greeff found that division of the cell is facultative and optional, following the nuclear division, and if it occurs, the cell-bodies are apt to fuse again. In low forms of Protozoa conjugation also is as facultative as with those protophyta, where both male and female parthenogenesis have been noticed.

We may get conjugation between ordinary zooids, or one of the gametes may be a microgonidium while the other, not having divided so fast, remains as a macrogonidium. Again, the gametes may be due to spore formation; and here, again, the spores may be alike or unlike, and conjugation may be between like spores, or may be between macrospores and microspores. If the conditions of life are equal, the more often the cell-division has taken place the stronger is the desire and need of conjugation, so that where macrospores are parthenogenetic, microspores may be gametes. That this need of conjugation does not depend on the small quantity of idioplasm present may be gathered from two facts: first, when spore formation succeeds conjugation the resulting spores are smaller and more numerous than if parthenogenetically produced, but whereas the latter are apt to be gametes the former grow with vigor and multiply rapidly; secondly, where cell-multiplication allows time for the cell to grow as in ordinary gonidia, gametes are just as apt to form. In spore formation the microspores are not gametes more often than the macrospores because they are small, but because they have undergone division more frequently. In forms where both gonidial and sporular gametes occur, a failure to conjugate in the gonidial stage insures conjugation of the spores, while the occurrence of conjugation in the gonidial stage insures sporular parthenogenesis.

The Vorticellæ enable us to understand that fertilization has to do with quality of the gemmules and not with the number of these present. Two zooids which have resulted from the repeated division of a mother-zygote and standing near each other bend together and conjugate. But others just like these bud off a piece off the nucleus with some of the cytoplasm, and this goes swimming away until it finds the appropriate gamete (a macro-

gonidium) with which to fuse. As the chance of cross-fertilization is greater in proportion to the number of these microgonidia, they have acquired the habit of dividing a few times after their separation from the macrogonidium before starting out on their search for partners. Here, as with Arion, a small quantity only of the idioplasm is needed to effect fertilization. We do not contend that there may not be some advantage in starting with a large quantity of idioplasm, but we do call attention to the fact that, compared with the vigor due to the mixture of idioplasms of diverse experience, such advantage becomes quite secondary.

We may now pass to the consideration of the phenomena of copulation. The simplest cases join easily on to the case last considered. When the bud from the nucleus is not carried away by cell-division it may still be transferred to the interior of another cell, if such cell be brought with an aperture close to a corresponding aperture of its own cell. When the nuclear bud is produced at the time of the fertilization, Engelmann terms the gametæ "periodic hermaphrodites" (so far as this implies sex it is a misleading term). When, however, the nuclear bud remains as a permanent endoplastule and does not conjugate with the endoplast, except perhaps for a brief period in connection with fertilization, after which it is immediately budded off again to form the endoplastule, then Engelmann calls such a cell a "permanent hermaphrodite." In some cases the whole reproductive function may have passed over to the endoplastule, so that this never conjugates with the endoplast, but rather by its own division builds up the latter when this disintegrates. Periodic hermaphrodites are Stentor, Spirostoma, and Trachelius; while permanent hermaphrodites are Stylonychia, Euplotes, and Paramœcium.

Copulation is most frequent with the Ciliata, but has been observed in Peridinium and in one-chambered Rhizopods. An alternation of copulation with conjugation occurs in Stylonychia and in Platoum (Troglodytes). See Gabriel.

In connection with conjugation and copulation there is in all the higher forms a segmentation of the nucleus, or of the endoplast and endoplastule respectively. The last leads in the division, but is not divided up so finely as the endoplast. The phenomena are closely similar to those that accompany division. The cycle of segmentation and of fusion is passed through, so that the foreign idioplasm becomes incorporated into the nuclear

structure. Possibly it does not get thoroughly mixed with the nuclear idioplasm in a molecular or rather gemmular intimacy, but as this process of segmentation and fusion is repeated for each division, there is no reason to suppose that after a while this may not be attained. Thus it is that *every cell-division is a fertilization.*

In the conjugation of Stylonychia, there is a fusion of nuclei with nuclei across the body, first uniting the nuclei of the two gametes; and then the anterior nucleus (zygote) fuses with the posterior one, after which the two nuclei are reconstituted. Possibly, Engelmann says, the nucleoli (endoplastules) do likewise. In copulation of Stylonychia there is segmentation of the nuclei and probably of the nucleoli, but Engelmann was unable to observe any transfer of material between the gametes. The nuclear fragments fuse to one body and bud off the nucleoli, but here there is disagreement, for in another case it seemed as if the nuclear products were extruded (Bütschli), the nucleoli became four in number, one disappeared, two became the new nucleoli, and the fourth, dividing, formed the endoplasts.

In copulation of Anoplophrya, Schneider could not observe any exchange of nucleoli, but the nuclei sent processes into the apposed cell, which became budded off mutually and fused with the remnant of the original nucleus to form a new nucleus, while the nucleolus came from one of the four segments into which the nucleolus divided; the other three disappeared. In Paramæcium, the endoplastule and the endoplast get segmented, the former usually into four, the latter into many, granules. Then there is a fusion of the fragments, but as to how this is done, and as to whether there is any mutual interchange of idioplasm, is a question which has received a dozen different answers.

Greeff thought the nucleolus was a semen capsule and the nucleus an ovary. The "eggs" that came from the "ovary" being fertilized, developed to living embryos viviparously. Stein called that part of the nucleus which remained after budding off eggs the "placenta," Balbiani, that the eggs were laid, and Engelmann also, with many other early observers, held views of a similar nature, according to which we had here a true hermaphodite. Engelmann subsequently modified his views to some extent, but Bütschli attempted to bring the phenomena into line with his observations on tissue-cells, and so he held that the nucleus is

extruded, due to fertilization, and a new nucleus arises endogenously, and this is *rejuvenescence*. In 1882, Balbiani showed that there was an interchange of nucleoli; and Jickeli, in 1884, saw two nucleoli in the act of passing each other, across the line separating the gametes. Lankester could find no interchange, but said that a portion of the segments of both bodies are lost, the remaining ones fuse to constitute the new nucleus and nucleolus, but *with reversed functions*. (See Fig. 128.)

Maupas, in 1886, said all the products of the nucleolus are lost except one; this divides, and one daughter remains and one crosses to the other gamete to fuse with the stay-at-home over there. The resulting zygotes segment to eight daughters; of these, three are absorbed, four become nuclei, and the eighth, after repeated divisions accompanying cell-division, becomes four nucleoli. The old nucleus is absorbed. Plate, in the same year, saw no interchange, but did see two nucleoli in apposition with a wall between. Gruber, however, saw the same thing, but no wall between, so that there was a chance for some interchange of substance. There was no fusion, however, for the nucleo-gametes separated and returned to divide into four. Gruber thinks the "stay-at-home" nucleolus acted in a similar way, for eight nucleoli result, and four of these fuse to form a new nucleus, the other four fuse to make a new nucleolus.

Truly, when such eminent observers disagree, who can decide? For our present purposes it is sufficient to know that there is an interchange in this case as in all others of fertilizing material, and that this is mutual and reciprocal. We cannot here, as did the older observers, speak of male and female idioplasm. That the functions of the endoplast are different from those of the endoplastule is evident, but Weismann claims that the reproductive plasma is restricted to the latter, while the former has only histogenic plasm. Thus, from a survey of fertilization in its relation to the nuclear phenomena, have we been enabled to get pretty clear notions of the significance of sex. But our morphological inquiry would not be complete did we not study the various methods of cell reproduction and observe the relations of these to the production of gametes. Several of the laws discoverable through such a survey have already been anticipated, but others will appear that are needful to the proper comprehension of the significance of sex.

Briefly, then, in conclusion, we have shown that the phenomena of life are the manifestation of forces that are organized, by being in some way connected with an ultimate unit, which unit, by multiplying and differentiating, forms units of a higher order; and these units repeat the same process, and so we get higher and higher units capable of a more complex life. Only in this way is organic life connected with inorganic life. A series of discrete degrees separates such life, as we study with the lens, from the substances with which the chemist deals. We can study the higher stadia morphologically, and only by analogy do we guess concerning the nature of the lower. We find the cell a reticulum of hyaloplasm holding microsomata in its nodes as nuclei. We find the soma of a metazoon likewise a reticulum in which the cell is the unit. As in the body, all cells come from embryonic or germinal cells, all traceable back to a single egg, so in the cell, all the differentiated gemmules, or micellæ, or tagmata[1] are descended from nuclear idioplasm, which is itself due to the multiplication of a single gemmule. Finally, we find that cell phenomena are accompanied by fusion or mixture of idioplasms that have had diverse experiences, and in some way the cell-life is thereby invigorated. Sex has been evolved as the means of effecting such fusions. The distinction of male and female has arisen comparatively late and is coupled with very secondary characters.

We have seen that half a dozen different structures are present in the cell, and that those in the spermatozoon are transformed into the different parts of its structure. Undoubtedly in the metamorphosis of all tissue-cells these structures play a part. If we could see which of these structures preponderates in a given tissue or organ, we could infer that the function of this part is similar in the cell to the function of the tissue in the soma.

Gaule's work on the cytozoan, or paranucleus, which can wander from cell to cell, and on which the cell-life depends, is yet too little known to be criticised. We may expect fuller details when Gaule has completed his researches.

[1] The ferments such as zymogen, etc., which are lower in the scale of organization than the bacteria, seem to come in somewhere near the plane occupied by the *gemmule;* but their relation to the latter is probably at present beyond the scope even of a guess.

LITERATURE BEARING ON THE SIGNIFICANCE OF THE CELL-NUCLEUS TO THE PROBLEM OF SEX.

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NOTE.—The substance of what has been published under the head of Significance of Sex was originally delivered as part of a series of lectures in the spring of 1886, from random notes. In preparing the article for publication I have added historical matter and the latest literature, but the plates having been first prepared, do not contain, as they otherwise would, some of the instructive figures which accompanied this later literature.

JOHNS HOPKINS UNIVERSITY, March, 1887.

THE TACONIC QUESTION RESTATED.

BY T. STERRY HUNT.

(Continued from page 125.)

§ 15. WE have said above that Emmons, in his "Agriculture of New York," published in 1846, referred the upper portion of his Taconic to the horizon of the Calciferous Sand-rock. It is, however, important to note that in Chapter V., there devoted to the account of the "Taconic System," and previously printed separately in 1844, two years earlier, he still adhered to the

opinion expressed in 1842, that the whole Taconic system was "inferior to the Potsdam sandstone," and repeated, in 1844, that "the Taconic system occupies a position inferior to the Champlain division of the New York system, or the lower division of the Silurian of Mr. Murchison." In support of this view he attempts, in 1844, to show that both the Potsdam sandstone and the Calciferous Sand-rock are found, the latter at intervals to the east of the valley of the Hudson, reposing upon the slates of the Taconic system, but adds, "probably, however, upon the Magnesian slates," which, as we have seen (§ 12), were assigned by him to a horizon below the group called by him distinctively the "Taconic slates," and were subsequently included in his Lower Taconic, the latter being Upper Taconic. In the same volume, in a subsequent chapter, which first appeared in 1846, or two years later, he had, however, arrived at the conclusion that the Calciferous Sand-rock to the eastward becomes more largely developed, and, losing the distinctive character which had given that name to the west of Lake Champlain, becomes, to use the expression of Emmons, "protean" in its modifications. Among these he now included the red sandstones of Addison, Charlotte, and Burlington, Vermont, with their interstratified red and chocolate-colored slates, besides blue limestones and gray calcareous sandstones, the whole resting upon what were designated as black Taconic slates. These so-called protean modifications of the Calciferous Sand-rock were now described by Emmons as forming an irregular belt from Canada through Eastern Vermont, thence traversing Washington, Rensselaer, Columbia, and Dutchess Counties, and crossing the Hudson into Orange County. This series, more or less interrupted in its geographical distribution, but including areas of some miles in extent, is described as "often forming the highest points in the region," and Emmons remarks, "We can hardly avoid the conclusion that this belt was once continuous, and formed an important mass overlying the Taconic slate."[1]

§ 16. It is scarcely necessary to remark that this great belt of sandstones, slates, and limestones, now described by Emmons, in 1846, as belonging to the Calciferous Sand-rock, and as resting on Taconic slates from Canada to Orange County, N. Y., is no other than the First or Transition Graywacke which, with the

[1] Agriculture of New York, vol. i. pp. 118–122.

same geographical distribution and similar lithological characters, had long before been described by Eaton as resting unconformably upon the Transition Argillite (§ 2), and subsequently by Mather (§ 8) and (apparently) by Emmons (§ 10) had been referred to the horizon of the Second Graywacke. It will also be remembered that the Sparry Lime-rock, which we know forms an upper member of this Graywacke series, was already by Eaton, in 1832, regarded as the stratigraphical equivalent in the eastern region of what he had called the Calciferous Sand-rock to the west of Lake Champlain. Emmons had thus in 1846, after his previous statements printed in 1842 and 1844, arrived to the same conclusion as his old master, and now assigned the great mass of uncrystalline more or less fossiliferous strata, which he subsequently called Upper Taconic, to a horizon below the Trenton limestone, and regarded it as the equivalent of the Calciferous Sand-rock, including, however, as he afterwards taught, also the representative of the Potsdam sandstone. When he speaks of this great Graywacke group as resting on Taconic slates, we must remember that already in his first recognition of the superposition of Calciferous Sand-rock to Taconic slates in 1844, as above cited, he had declared these to be "probably the Magnesian slates," which correspond to the Transition Argillite of Eaton, included in the Lower Taconic, and not to what he elsewhere designates as the proper "Taconic Slate" group, which was later included in his Upper Taconic, and is no other than this same "protean" Calciferous Sand-rock and Potsdam sandstone, or the First Graywacke itself.

§ 17. Emmons could scarcely have defined more clearly than he did in 1844[1] the great extent and the boundaries of this Taconic slate group as then known to him, with its breadth of fifteen or twenty miles, occupying the greater part of the three counties named in Eastern New York, and stretching from north to south one hundred and fifty or two hundred miles; its limitations on the west by the overlapping upper members of the Champlain division, and on the east by the great mass of the Sparry limestone, portions of which are said to occur at intervals in the section farther westward. He, moreover, declares in 1844,

[1] Agriculture of New York, i. 65–72. We quote from this volume for the reason that it is more generally accessible than the first and separately printed edition of the monograph.

that in this Taconic slate group—described in 1842 as "often becoming a coarse graywacke" and now called "protean"—are numerous subordinate divisions, among which he mentions coarse greenish sandstones, gray sandstones, red and chocolate-colored shales, roofing-slates, green and black flinty slates, blue compact limestones, and gray silicious limestones, all of which are included in this great disturbed and faulted belt of uncrystalline strata. One of these subdivisions he described as a black slate with trilobites, and noticed another containing impressions resembling graptolites. In further proof of the fossiliferous character of this great Taconic slate group, which he had already, in 1842, referred to "the lower part of the Silurian system," he declared that besides these in the black slates just mentioned he had found fossils in the green sandstones and the green slates; while with regard to the Sparry limestones he remarks that "no fossils have yet been discovered in this rock, though it must be confessed sufficient examination has not yet been made for microscopic bivalves."

§ 18. It is here important to remark that the term "Taconic slate" applied to this upper and notably fossiliferous portion of the Taconic system of Emmons has led to the erroneous opinion that it is in some special sense the representative of the system, and to look upon the lower members as of less significance; a view which, it is unnecessary to say, finds no countenance in the publications of Emmons. Eaton, as we have seen, asserted the existence of a stratigraphical break between the Taconic slate, his First Graywacke, and the underlying Transition Argillite. This upper unconformable portion was afterwards separated by Emmons from the inferior members of the system, and designated Upper Taconic. In his "American Geology," in 1855, he in fact proposed to consider the Taconic system as consisting of two parts, between which, according to him, "the line of demarcation is tolerably well defined." Of these, the lower part, henceforth called by him Lower Taconic, included (1) the Primitive Quartz-rock, (2) the Primitive Lime-rock, or Stockbridge limestone, and (3) the Transition Argillite, or Magnesian slate, with the lower roofing-slates. The Upper Taconic included the great group of the First Graywacke, called by Emmons, in 1842 and 1844, the Taconic slates, with the Sparry Lime-rock, called by him the Sparry limestone. This same view is again set forth by Emmons,

in his "Manual of Geology" in 1860, and in his subsequent reports on the geology of North Carolina.

§ 19. It is important to note that the line of demarcation between the Lower and Upper Taconic series corresponds to the stratigraphical break already pointed out, in 1832, by Eaton between the Transition Argillite and the First Graywacke. It should be further mentioned that this division is one between a series of essentially crystalline strata below and one of earthy sediments above; and, moreover, that the facts known with regard to the distribution of the two show clearly that their areas are not co-extensive. While found superimposed upon the Lower Taconic in certain districts, the Upper Taconic is wanting over great areas of the Lower, and is elsewhere seen in many places resting unconformably upon pre-Taconian crystalline schists.

It was this Upper Taconic which Emmons, in 1842, declared to belong to "the lower part of the Silurian system," which he showed, in 1844, to contain organic remains, such as trilobites and graptolites, in several of its subdivisions of shales and sandstones, remarking that while they had not yet been found in the Sparry Lime-rock sufficient search had not been made therein. It was the same Upper Taconic or Taconic slate group which he later, in 1860, declared to correspond to the Primordial zone of Barrande, which latter was included alike by Barrande and by the other followers of Murchison, both in Europe and America, in the so-called Silurian system. Yet, notwithstanding all these facts, we find that the discovery in Eastern New York of fossils of Cambrian and Ordovician age in what J. D. Dana calls "a limestone of the original Taconic of Professor Emmons,—his Sparry Limestone,"—is brought forward in 1885 as an argument against the views of Emmons. In a letter to Marcou, dated Albany, September 1, 1860, Emmons writes, "The upper part of the Taconic is equivalent to Barrande's Primordial group," while in his "Manual of Geology," also published in 1860, he declares (p. 89) that "it has been shown that the Primordial zone in Bohemia is in co-ordination with the upper series of the Taconic rocks." In another letter to Marcou, in November of that year, he expressed the opinion that neither his Taconic system nor the Primordial zone or group of Barrande was Silurian, but in a subsequent letter, November 29, 1860, admits his misconception and writes, "On reading his [Barrande's] papers I found that, after all,

his Primordial group is only Lower Silurian. I conceive that we have exactly his Primordial group in the band of slates containing the Paradoxides." (Olenellus.)[1]

§ 20. The study of these Upper Taconic rocks in the province of Quebec by the geological survey of Canada was carried on in the vicinity of the city of Quebec in 1852–1855, the present writer being at intervals an assistant to Logan in his field-work in that district. The official reports of Mather and Emmons on the geology of New York were then repeatedly consulted, and the Taconic system of the latter being then generally discredited, the passages in accordance with the views of Mather, which, as we have already noticed, are to be found on certain pages of that volume, were alone accepted, and the Graywacke series of Quebec and its vicinity was referred to the horizon of the Second Graywacke of Eaton. This great thickness of contorted shales and sandstones, with intercalated limestone and dolomite beds, already described, in 1827, by Bigsby as "a slaty series of shales and graywacke," was then called Hudson River group, and assigned to a position above the horizontal and well-characterized Utica and Trenton divisions found a very few miles away on the west side of the St. Lawrence, while the green sandstones which apparently overlie these inclined strata were designated Oneida sandstone. They were thus described and mapped in the "Esquisse Géologique du Canada," bearing the names of W. E. Logan and the present writer, but prepared by the latter, and published in Paris in 1855.

§ 21. The great belt of disturbed strata described, in 1827, by Bigsby as "a slaty series of shales and graywacke," which by the united labors of Eaton, Emmons, and Logan had now been traced with little interruption from the banks of the St. Lawrence below the city of Quebec, along the west side of Lake Champlain, and thence nearly to the Highlands of the Hudson, constituting the Upper Taconic of Emmons and the larger part of the Hudson River group of Vanuxem. That this, contrary to the teachings of Eaton, but in accordance with the views of Mather, was regarded as above, and not below, the horizon of the Trenton limestone appears, from James Hall's Report to the geological survey of Canada, published in 1857, on the grapto-

[1] Letter of Emmons to Marcou, November 20, 1860, in Marcou's "Taconic System."

lites of Pointe Levis, which were then described as belonging to a higher horizon than the Utica slate, and in the words of Hall, to "that part of the Hudson River group which is sometimes designated as Eaton's Sparry limestone,—being near the summit of the group." Still later, in 1859, with regard to the trilobitic strata of the town of Georgia, Vermont (the "slates with Paradoxides" of Emmons, noticed in § 19), Hall wrote, "I have the testimony of Sir William Logan that the shales of this locality are in the upper part of the Hudson River group, or form part of a series of strata which he is inclined to rank as a distinct group above the Hudson River proper."

§ 22. It was in 1856 that the finding by the present writer of an unknown trilobite in one of the many limestone bands of this Graywacke series at Pointe Levis, opposite the city of Quebec, led to further researches, revealing in that series a fauna which furnished to Billings convincing proof that the view of Eaton and Emmons was the correct one, and that this same Graywacke, or Hudson River group, was below and not above the horizon of the Trenton limestone, and was in fact the First and not the Second Graywacke of Eaton. This was first admitted by Logan in a letter to Barrande, dated December 31, 1860, but published in 1861.[1] In this, referring to the trilobitic beds in Vermont noticed above, which he had placed at the summit of the Hudson River group, but now declares that he had "recognized as equivalent to the magnesian part of the Quebec group," Logan writes, "Prof. Emmons has long maintained, on evidence that has been much disputed," that these rocks "are older than the Birdseye formation" (the basal beds of the Trenton), and adds, "the fossils which have this year been obtained at Quebec pretty clearly demonstrate that in this he is right."

Refusing, however, to adopt the name of Upper Taconic or that of the First Graywacke, Logan, for reasons of his own, chose to give to these rocks the title of the Quebec group, a name which he extended to the whole belt from the Lower St. Lawrence to the valley of the Hudson River, and henceforth made no further allusion to Emmons, whose views he had now adopted. In accordance with the teachings of Emmons in 1846 and 1855, these rocks were now declared by Logan to be a great development of sediments about the age of the Chazy and the

[1] American Journal of Science, xxxi. 220.

Calciferous divisions of the New York system. The Red Sand-rock included in this belt in Vermont was, however, subsequently, from its fauna, referred by Billings of the Canada geological survey to a lower horizon, the so-called Lower Potsdam, and an attempt was made to establish a Potsdam group beneath the Quebec group, including both the Red Sand-rock (which Logan, in 1859, had placed above the summit of the Hudson River group) and a group of strata at Farnham in Quebec, which are, however, of Chazy if not of Trenton age.

§ 23. The subsequent history of Logan's endeavor to separate the Graywacke series, as displayed near the city of Quebec, into what he called the Levis, Lauzon, and Sillery divisions of the Quebec group, and his conjecture that the apparent order of superposition in the section there exposed represents the real or true order has been elsewhere told in detail. By his adoption of this conjecture the Levis or Sparry Lime-rock was put at the base, and the massive green Sillery sandstone at the summit of a Graywacke series of many thousand feet, all of which was but a reaffirmation of the old hypothesis of 1855, which had made this sandstone the Oneida, and the underlying gray sandstones, with shales and limestones, the equivalent of the Loraine. That this apparent order was contrary to palæontological evidence was pointed out by Billings, who insisted that the horizon of the Sparry Lime-rock, and its adjacent Phyllograptus shales, was somewhat above the typical Calciferous Sand-rock of New York, and that the massive green sandstones belonged to a much lower horizon.

Logan, although he had borrowed from Emmons the conception that the great Graywacke series was really below the horizon of the Trenton limestone, still adhered to the stratigraphical scheme which he had framed when he believed that the section at Quebec and Pointe Levis represented the Loraine shale, with a great overlying mass of green sandstones with conglomerates and red shales, corresponding to the Oneida of the New York system. These sandstones, he now thought, might correspond to the St. Peter's sandstone of the Upper Mississippi, and to the sandstones and shales which in parts of the Ottawa basin appear in the Chazy subdivision. The history of all this has been set forth in the writer's volume on "Azoic Rocks, etc."[1] The dif-

[1] Second Geological Survey of Pennsylvania, Report E, 1878.

ferences between Billings and Logan on these points appear in the volume of the former on "Paleozoic Fossils,"[1] and more fully in the instructive correspondence of Billings with Jewett and Marcou, lately published by the latter in his paper on the Taconic system in 1885.[2]

§ 24. James Hall, who had in 1857 declared that the graptolitic slates found in conjunction with the Sparry Lime-rock at Pointe Levis, the Levis limestone of Logan, were at the summit of the Hudson River group,—employing this term, as he had always done, as synonymous with Loraine shales,—was led by the palæontological discoveries in Vermont, and near the city of Quebec, to reconsider the age of this so-called group and the true significance of the term. In his "Report on the Geology of Wisconsin" in 1862 (p. 443), he referred to the evidence furnished by organic remains in the rocks of the Graywacke belt in the province of Quebec and in Vermont, "which prove conclusively that these slates are to great extent of older date than the Trenton limestone," though probably newer than the Potsdam. He remarked, moreover, that "the occurrence of well-known forms of the second fauna . . . in intimate relation with, and in beds apparently constituting a part of, the series along the Hudson River, requires some explanation. Looking critically at the localities in the Hudson valley which yield these fossils, we find them of limited and almost insignificant extent. Some of them are on the summits of elevations which are synclinal axes, . . . where the remains of new formations would naturally occur. Others are apparently unconformable to the rocks below, or are entangled in the folds of the strata, . . . while the enormous thickness of beds exposed is almost destitute of fossils." He hence concluded that the name of Hudson River group cannot properly be extended to the great mass of strata which had hitherto borne that name, but which he now regarded as distinct from "the Hudson River group proper."

§ 25. Thus while still retaining for the Loraine shales the name under which Vanuxem had, in 1842, included alike these shales and the great underlying mass of older strata belonging to two lower horizons which constitute by far the larger portion of the

[1] Geological Survey of Canada, 1865; Paleozoic Fossils, vol. i. *passim*.

[2] Proc. Amer. Acad. Sciences, New Series, vol. xii. pp. 174–256. See also therein the letters of Emmons and Marcou, pp. 184–201.

rocks hitherto called Hudson River group, Hall admitted the distinctness and the greater antiquity of these. In 1877, while justifying the retention of the name of Hudson River group for the fossiliferous rocks of Loraine age found along the banks of that river, and originally called "Hudson slates" by Mather,—which Hall speaks of as "the newer series, or the rocks above the Trenton limestone," as contradistinguished from the older or infra-Trenton series,—he admits that "the error lay in extending the term [Hudson River group] to rocks on the eastward, at a time when their fossil contents had not been studied . . . and their geological position had not been determined by critical examination."[1]

The geological position of these rocks to the eastward and their relation to the newer series had, however, already been determined, and Hall, in 1862, did but repeat the statements long before made by Emmons, who, in 1842, had declared that the Taconic slate group was undoubtedly overlapped along its western border by "the Loraine or Hudson River slates." Again, in describing, in 1846, beds of the Loraine shale alternating with the sandstone of the Gray band in the valley of the Rondout, and in their northern outcrop along the termination of the Helderberg range, Emmons declares that this section of the Loraine strata "resembles the beds which occur in patches on the east side of the Hudson along the Western [Boston and Albany] Railway. These latter beds may be clearly distinguished from the slates and shales of the Taconic system. They neither conform with them in dip nor in strike," and, except in the immediate vicinity of the great northern fracture of the Hudson valley, their dip and their disturbance are not excessive. These unconformably overlying areas of Loraine shales resting on the older Graywacke were said to form a small range between Chatham Centre and Chatham Four Corners, "where they lie in deep troughs and are exposed in the railway cuttings." In some cases, we are told, "their peculiar distribution and the confined limits of the fossiliferous beds render quite difficult the recognition of these shales when they lie in proximity to the Taconic system."[2] It was thus clearly shown by Emmons, in 1844, that the Loraine shales not only overlie the Upper Taconic or First Graywacke along its

[1] Proc. Amer. Assoc. Adv. Science, 1877, p. 263.

[2] Emmons, Agriculture of New York, pp. 124, 125, 128.

western border in New York, but are found thereon in small unconformably overlying areas, as was admitted by Hall in 1862.

§ 26. These facts regarding the relation of the Loraine shales to the great Graywacke belt were set forth by the writer in 1878. It was at the same time shown that within the limits of this belt, in the province of Quebec and in Vermont, there were found organic forms ranging from a horizon at least as low as the Potsdam (the Olenellus or Lower Potsdam beds of Billings, which were the Paradoxides beds of Emmons) to the Phyllograptus shales (belonging to the horizon of the Arenig or Skiddaw of Great Britain), without counting the fossiliferous beds at Farnham, Quebec, assigned by Logan to the base of the Quebec group, but shown by Billings to be not lower than the Trenton. In other words, it was set forth that this First Graywacke, otherwise called the Taconic slate group, Upper Taconic and Quebec group, had been by Emmons, as long ago as 1842, declared to belong to the age of the Silurian of Murchison; that he had shown it in 1844 to contain in its various subdivisions trilobites, grapolites, and fucotids, and had in 1860 referred the same Taconic slate group to the Primordial zone, or so-called Primordial Silurian of Barrande. Still further, it was shown that it had been maintained by Emmons in 1844, and confirmed by Billings, that within this belt were accidentally included unconformable portions of post-Trenton fossiliferous strata of the Champlain division.

It was further pointed out by the writer in illustration of these facts that similar conditions appear in the basin of the Ottawa, near the city of that name, where, as the result of an unconformity between the upper and lower members of the Champlain division, a belt twenty miles long of shales and sandstones, carrying the fauna of the Utica and Loraine subdivisions, is found lying transgressively alike on the Trenton, Chazy, and Calciferous subdivisions, as long ago shown by Logan.

§ 27. The observations of Ford, Dwight, and Dale along the great Graywacke belt to the east of the Hudson, in the State of New York, which show, besides a Cambrian fauna of Potsdam and Calciferous age, the presence of small areas of strata belonging to the higher divisions of the Champlain divisions, are thus in direct confirmation of the original statements of Emmons, the later determinations of Billings, and my own teachings. They show

the horizon of the Upper Taconic or Taconic slate group—the Transition or First Graywacke of Eaton—to be, as taught by Emmons in 1842, the lower part of the Silurian system, as he understood it, and as he later declared it to be, the Primordial zone or Primordial Silurian of Barrande. If, then, we except small areas of true Silurian (Lower Helderberg) and possibly Devonian strata, as at Becraft's Mountain, near Hudson, New York, and, according to James Hall (as cited by Edward Hitchcock), in Vermont, it will be seen that the great belt of Graywacke, stretching from the St. Lawrence to the Hudson River in Dutchess County, is of Cambrian age, with overlying and included patches of Ordovician (Chazy-Loraine) and a few small areas of Silurian.

It may here be added that the evident ignorance of these historical facts which is apparent therein, is the only excuse which can be pleaded for the misstatements which have of late years been repeatedly put forward with regard to this important problem in American geology.

§ 28. Marcou, who had already, in 1880, insisted thereon, declares in 1885, the "time has now come to make clear the prior right and the real advantage to be found in the use of the term 'Taconic System,' instead of the so generally employed expressions 'Cambrian' and 'Silurian,' to designate the strata enclosing the Primordial fauna.[1] In answer to this proposition, it is to be said that the names of Silurian and Cambrian were proposed for the great Transition or Graywacke series of Wales by Murchison and Sedgwick in 1835 and 1836. We need not here repeat the long history which I have elsewhere told,[2] of the means by which it was sought by Murchison to include in his Silurian the greater part of the Cambrian of Sedgwick, a task in which he was seconded by Barrande, who called the horizon of the lowest Cambrian fauna —his Primordial zone—Primordial Silurian.

In the great work of the New York geological survey, begun in 1837 and summed up in the final reports of 1842 and 1843, a succession was independently wrought out for the American palæozoic basin, in which were named the "New York System" and the "Taconic System." As regards the probable parallelism of these with the previously-named Cambrian and

[1] The Taconic System, Proc. American Academy of Sciences, 1885, xii. 244.

[2] Hunt, History of Cambrian and Silurian, Chemical and Geological Essays, pp. 349–425.

Silurian, we find Emmons, in 1842, suggesting that the Taconic rocks in part might "be equivalent to the Lower Cambrian of Sedgwick," "the upper portion being the lower part of the Silurian System," to which the Middle and Upper Cambrian of Sedgwick were then, on the authority of Murchison, very generally referred. To repeat what we have already said, we add that this upper portion, the fossiliferous character of which he made known in 1844, was by Emmons declared, in 1860, to correspond to the Primordial of Barrande. "The upper part of the Taconic is equivalent to Barrande's Primordial zone," and again, "His Primordial group is *only Lower Silurian.* I conceive that we have exactly his *Primordial group* in the band of slates containing *Paradoxides.*"[1]

The names of Cambrian and Silurian were thus prior to that of Taconic, and so far as regards the Upper Taconic, it is now shown by palæontological studies to be unquestionably the stratigraphical equivalent of the great mass of the Cambrian of Sedgwick, including accidentally, as we have seen, small portions of his Upper Cambrian (Ordovician), but excluding, so far as yet known, the lowest Cambrian or Paradoxides horizon. It remains to be seen whether American or European geologists will abandon the accepted and well-defined terms of Cambrian for that of Taconic.

(To be concluded.)

NOTES ON THE GLACIATION OF THE PACIFIC COAST.

BY G. FREDERICK WRIGHT.

I HAVE elsewhere (see *Am. Jour. Sci.* for January) given an account of the results of my observations during last summer on the Muir Glacier, Alaska. The journey to and from that point of interest afforded equally good opportunities for observation.

The Northern Pacific Railroad passes out of the glaciated region at Sims' Station, Dakota, about forty miles west of Bismarck, at an elevation of two thousand two hundred and eighteen feet

[1] The italics are as found in the printed text.

above tide and three hundred and fifty above the Missouri River. The passage from the glaciated to the unglaciated region is quite marked and can easily be detected from the train. From this point on to the west no signs of glaciation appear until passing the western ridge of the Rocky Mountains near Lake Pend Oreille in Idaho. Here the movement was towards the west and was evidently local. Water-worn pebbles from this vicinity were observed far down in Eastern Washington Territory, in old water-courses, or "coulees," worn by post-glacial streams in the extensive lava deposits of that region.

West of the Cascade Mountains, between Portland and Seattle, all the streams coming down from Mount Rainier and its companions are heavily charged with glacial mud, and can be traced to extensive glaciers in the mountains. The White River Glacier, on the north side, is the largest of these. This glacier is from one to one and a half miles wide at its termination, which is about five thousand feet above tide. Two or three miles farther up it is about four miles wide. It is about ten miles long, and in its higher level merges in the general ice-cap which envelops the upper five thousand feet of the mountain. The height of the mountain is fourteen thousand four hundred feet.

The north and south valley between the Cascade Mountains and the Coast Range in Washington Territory is about one hundred miles wide. The northern half of this is penetrated by the innumerable channels and inlets of Puget Sound, which extends from Port Townsend south about eighty miles to the parallel of Mount Rainier. The Olympian Mountains to the west rise to a height of about ten thousand feet, as does Mount Baker in the Cascade Range to the northeast. The shores and islands of Puget Sound have every appearance of being a true glacial accumulation. No rock in place anywhere appears. The shores and islands rise from fifty to two hundred feet above tide, and present a mixture of that stratified and unstratified material characteristic of the terminal accumulations of a great glacier. Boulders of light-colored granite and of volcanic rocks are indiscriminately scattered over the surface and embedded in the soil. One of these boulders near Seattle, two hundred feet above the sound, was twenty feet in diameter and twelve feet out of ground. The channels of the sound and of the adjacent fresh-water lakes have a general north and south direction, parallel with the axis of the

valley. This is specially noticeable near Seattle, where Lake Washington, elevated sixteen feet above tide, and twenty-five miles long, is strictly parallel with the sound, and is separated from it by a series of ridges showing every mark of glacial origin. Not only is the surface of these ridges covered with boulders, but wherever the streets have cut down into the soil they show, at the depth of a few feet, an unstratified deposit abounding in striated stones. Superimposed upon this ridge there is a thin stratified deposit of varying depth but increasing in extent down the slope towards tide-water. At Port Townsend, on the Strait of Juan de Fuca, and forty miles north-northwest of Seattle, the coarsely stratified deposit is much greater in extent. A noteworthy section of this I had the privilege of studying at Point Wilson, two and a half miles northwest of Port Townsend. Here, facing the strait, is a perpendicular bluff from one hundred and fifty to two hundred feet in height, composed, in its lower portion, for about one hundred feet of rather fine, stratified material, which is capped at the summit by about fifty feet of coarse, unstratified material abounding in large striated boulders, which as they have been washed out by the erosion of the sea have fallen down to the foot of the bluff in immense numbers. Near the bottom of the bluff there are several strata of vegetable deposits. One of these, two feet thick, consisted almost wholly of the fragments of the bark of the fir-trees which are now so characteristic of that region. Fragments of wood project from the freshly exposed bank in great abundance. The meaning of these facts will be more readily apparent after a study of the phenomena to the north of the strait.

The Strait of Juan de Fuca is from fifteen to twenty miles in width, running east and west. Its north shore, near Victoria, on Vancouver's Island, is remarkably clear of glacial débris. The rocks, however, near Victoria exhibit some of the most remarkable effects of glacial scoring and striation anywhere to be found. Immediately south of Victoria long parallel furrows rise from the shore of the inlet and ascend the slope of the hill to the south to its summit, a hundred feet or more above the water-level. At the steamboat-landing, outside of the harbor, extensive surfaces freshly uncovered exhibit the *moutonnée* appearance of true glaciation, and, in addition to the finer and abundant scratching and striæ, display numerous winding furrows from six inches

to two feet in depth, and from twenty to thirty-two inches in width, and ten or more feet in length. These grooves are finely polished and striated, resembling those with which geologists are familiar on Kelly's Island, Lake Erie. Like the corresponding grooves on Kelly's Island, some of these also turn around the southern point in graceful curves, adjusting themselves to the retreating face of the rock-wall. That the motion of the ice here was to the south is evident not only from the direction of the striæ, but from the fact that the stoss side of the glaciated rocky projections are towards the north. That they are due to glacial action, and not to icebergs, is evident both from their character and from their analogy to numerous facts farther to the north, which are unquestionably connected with true glaciers.

Vancouver's Island, which trends parallel with the shore of the continent, northwest by southeast, is nearly three hundred miles in length, and from fifty to seventy-five in breadth. In character it seems but a continuation of the Coast Range of mountains, with numerous peaks rising from four to seven thousand feet above the sea. The shore-line of the continent upon the northeastern side of the Strait of Georgia is formed by a continuation of the Cascade Range, with a general elevation of from three to eight thousand feet, penetrated in numerous places to a distance of seventy-five miles by inlets or fiords several miles in width. Mr. George Dawson has described the glacial phenomena in Bute Inlet, which enters the Strait of Georgia about opposite the centre of Vancouver's Island, in latitude 50° 30′. He describes the chasm (see *Quarterly Journal of Geolog. Soc.*, vol. xxxiv. p. 89) as forty miles in length, surrounded by mountains, rising in some places in cliffs and rocky slopes from six to eight thousand feet. "The islands about its mouth are *roches moutonnées*, polished and ground wherever the original surface has been preserved."

The mountains on either side the Strait of Georgia, and northwestward to the head of Lynn Channel, in latitude 59° 20′, are snow-clad throughout the whole season. The shores are everywhere rocky and precipitous, retaining in many places far up their sides glacial striæ parallel with the direction of the numerous channels which thread their way through the Alexander Archipelago. I had opportunity at Loring, on the western shore of Revilla Gigedo Island, to examine minutely the striation on the shores and islands of the bay. There are now no glaciers

coming down from the mountains of this island, but the shores and islands abound in well-preserved glacial striæ running W. by 18° N., corresponding to the direction of the local valley down which the glacier came, and entering Behm's Canal nearly at right angles to its course upon that side of the island. This is in latitude 55° 40′.

Upon proceeding one degree to the north, I had opportunity also to observe closely the striæ at Fort Wrangell. Here, too, they show the influence of the continental elevation to the east, and are moving outward in a westerly direction towards the Duke of Clarence Strait. About thirty-five miles up the Stikine River, two glaciers are encountered of immense size coming down, one from the north and one from the south, to the vicinity of the vast cañon through which the river runs. The glacier from the north is about forty miles long and two miles wide near its mouth, spreading out to five miles a short distance back from the river, which it approaches to within four hundred yards. The glacier approaching the river at this point from the south is not so long and reaches only to within about two miles of the river.. It is clear that a comparatively slight extension of these two glaciers would make them unite and close up the outlet of the river, and it requires no great stretch of the scientific imagination to see the whole valley occupied by a glacier, moving towards the ocean with an immense subglacial stream emerging at the ice front, wherever that might have been. From phenomena observed in Glacier Bay I am led to credit the tradition of the Indians that within historic times these glaciers met and the Stikine River made its way under them through an immense tunnel.

From the mouth of the Stikine River northwards, glaciers in great numbers and of great size are seen coming down from the mountains towards the sea-level, while all the mountains upon the islands are snow-clad through the whole summer, and some of them contain glaciers of small size. At Holcomb Bay and Taku Inlet glaciers come down to the sea-level and send off numerous small icebergs, which are frequently met with in Stevens' Passage. At the head of Glacier Bay no less than four glaciers of great size come down to tide-level, sending off immense numbers of small fragments and bergs. The evidence here of the recent vast extension of these glaciers down the bay, and of the facility of glacier-ice in adjusting itself to the local

topography, is of a most explicit and interesting character. The Muir Glacier, which is two miles wide at its mouth, is formed by the confluence of nine main streams, coming in majestic curves from the southeast, east, north, northwest, and west, and uniting in a vast amphitheatre of ice many miles in diameter a short distance above its present outlet. From the surface of this icy amphitheatre numerous islands project, as from the waters of an archipelago. The summits of these bear every mark of having been freshly uncovered by the decreasing volume of ice. Below the mouth of the glacier numerous islands in the bay present exactly the same appearance, except that they now project from water instead of ice. Their recent glaciation is indicated by every characteristic sign. Willoughby Island, about the middle of the bay, is as much as a thousand feet above the water. Were the ice to retreat a few miles farther, it would doubtless uncover an extension of the bay with numerous islands similar to those now dotting its surface south of the glacier. Fresh glacial débris lingers on the flanks of the mountains on either side of the inlet at a height of two thousand feet; and at three thousand seven hundred feet striæ were observed moving, not down the mountain, but parallel with the axis of the bay, showing that the present glacier is but the remnant of an ice-flow of similar character and direction of movement, but of vastly greater dimensions, extending and filling the whole bay to its mouth in Cross Sound, a distance of twenty-five miles. At Sitka the rocks in the harbor are all freshly striated, the direction of the movement being in a westerly direction, or towards the open sea. Glaciers still linger in the mountains at the head of the bay to the east of Sitka.

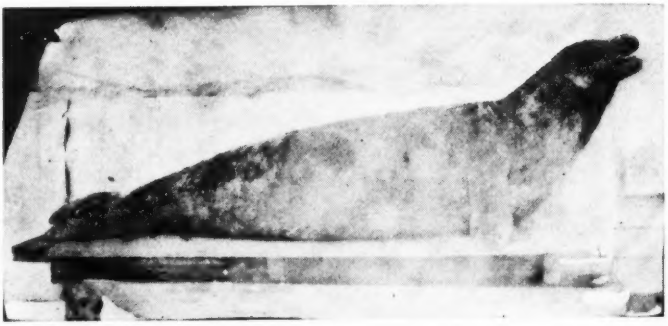
From all these facts it seems evident that we have only to suppose a slight increase of present forces favorable to the production of glaciers to find a state of things which will account for all the facts and unravel the whole intricate web of phenomena upon the western coast of North America.

The present formation of glaciers on the coast of Southeastern Alaska is favored not so much by the coolness of the climate as by the elevation of the mountains and the excessive amount of precipitation, which is not far from one hundred inches annually. There is no evidence that the elevation of the coast has materially changed in recent times. Nor is there evidence of any changes

in the amount of precipitation. It would only be necessary to suppose a slight diminution of temperature to secure all the additional force required to extend the present glaciers of Southeastern Alaska, British Columbia, and of the Cascade Range in Washington Territory and Oregon, until they should occupy all the channels of the Alexander Archipelago, fill the space occupied by the Strait of Georgia between Vancouver's Island and the main-land, and cover the whole valley between Mount Rainier and the Olympian Mountains, where now we find the vast moraine deposits of the islands and shores of Puget Sound. Southward, in Oregon, the Willamette valley is filled in a similar manner by an extension of the glaciers still lingering on the flanks of Mounts Hood and Shasta. The absence of drift on the southern shore of Vancouver's Island seems to point to a termination of the northerly movement in the Strait of Juan de Fuca, where, perhaps, the confluent streams turned westward and sent off vast drift-laden icebergs to the sea. Mount Baker, immediately to the east of this point, is upwards of ten thousand feet high, and still preserves glaciers on its flanks, and would have aided greatly in this movement.

In the boulders about Puget Sound, and in the striated surfaces which must exist somewhere in the vicinity, there is doubtless positive evidence of the direction of the ice movement which brought to its present position the immense ridges and piles of glacial débris forming the fertile soil of this remarkable region. It is to be hoped that local observers will not long leave the world in doubt as to the source of the boulders and the direction of the striæ about Puget Sound. To me the shores and islands of that region had the appearance of being the terminal deposits of confluent glaciers coming down from the flanks of Rainier to the southeast, and from the lower portions of the Cascade Range farther north, joined by smaller glaciers from the Coast Range on the west. It is clear that the earlier glacial movements on the Pacific coast were local in character, and must be studied independently of those east of the Rocky Mountains. The ancient glaciers of the Pacific coast can be understood only by reference to the glaciers which still linger at the head of all its numerous valleys, inlets, and fiords. In these the investigator has his *vera causa* ever before his eyes to guide his steps and to assist his imagination.

PLATE XII.



MONACHUS TROPICALIS.

NOTES ON THE LIFE-HISTORY OF MONACHUS TROPICALIS, THE WEST INDIAN SEAL.

BY HENRY L. WARD.

WHEN in 1494 Columbus was cruising among the West Indies with his little caravels, searching for the ever-delusive route to the kingdoms of the Grand Khan, towards the latter part of August his vessels became separated, and in order to spy out if possible the missing ones he came to anchor near a tall rock lying south of the centre of Hayti and called by him Alto Velo.

Sailors were sent ashore with orders to climb to the top and look out for the other caravels. Unsuccessful in their search for them, on returning to the ship "they killed eight sea-wolves (seals) which were sleeping on the sands."

This West Indian seal was consequently the first observed American mammal larger than the Coypu or Cane-Rat that probably had been seen at Cuba.

The next notice that we have of it was written by Dampier in 1675; then follow Hill's account in 1843, Gray's in 1849, 1850, and 1874, and Gosse's in 1851. This comprises all accounts of which I am aware that, based upon specimens in hand, appeared previous to 1884. Dampier and Hill and Wilkie (Gosse's account) in 1846 have given us the only records of observations concerning the life of this seal. Since then all trace of it has been lost, two small skins in Mexico and a single young one in this country comprising all the specimens known to be in existence up to the time that we obtained others.

Last fall I had consummated a plan to try and find this seal, when, hearing from Professor F. Ferrari Perez, of the Mexican Geographical and Exploring Survey, that he had the same object in view, we decided to join forces. Accordingly, in November last we met by mutual appointment at the city of Campeche. The Triangles, or rather the East Triangle, was the point at which we had decided to make our first search for Monachus. This is in lat. 20° 55′ N., long. 92° 12′ W., or one hundred and eight nautical miles in a northwesterly direction from the nearest point of the Yucatan peninsula. Distant two or three hundred yards in a northeasterly direction from the east island lies what I shall

designate as the North Triangle. The west island, distant seven and a half miles, was unvisited by us.

A brief description of the east and north islands, the ones at which we obtained seals, will be of interest as depicting one of the hitherto unknown habitat of this animal. They are of coral formation and surrounded by dangerous reefs that here and there have reached the surface, from twenty-seven to twenty-eight fathoms of water surrounding them. Meandrina, Millepora, and Madrepora were the three genera noticed, the former, by far the more common, forming the bulk of the islands and outlying reefs.

The East Triangle is an irregular oval in form, about half a mile in length by perhaps one hundred and fifty yards in greatest width. The northern part of the island is quite level, raised scarcely a yard above high tide, and consists of gleaming white coral sand interspersed with water-worn, rounded blocks of the same material.

These sandy portions of the islands were the principal "hauling-up" places of the seals. The southern part of the island is almost exclusively composed of these coral stones, strangely heaped up into pinnacles and ridges, about twenty feet above sea-level, between which lie gullies and circular pits six or seven feet in depth.

Beginning a little distance from the smaller end of this island, so as to include between itself and the land a narrow lagoon, runs a reef which, for its entire length awash, loses itself in the sea before it reaches the Northern Triangle. This island, of approximately half the area of the other, is quite similar to it in form and character. No trees or bushes grow upon either, three species of plants alone forming the observed vegetation. Two of these are trailing plants. The other, one of the Leguminoseæ, growing to a height of about two feet, formed sheltered nooks between the diverging stems, positions that were used as nests by the Booby (*Sula cyanops*) and the Man-o'-War-Bird (*Fregata aquila*). *Sterna maxima* was the only other bird noticed. Alacrans (scorpions) a black kind, abounded in the sandy places, causing one to be somewhat careful where he sat or what he picked off the ground. The house-fly completes the list of the air-breathing observed fauna.

Upon arriving at the islands we anticipated a stay long enough

to enable us to do all the work both upon seals and other objects that we might desire; but on the second day the barometer indicated the near approach of a "Norther," the severe winter wind of that part of the coast, and upon the third day we had hurriedly to break camp, even leaving some of our specimens, get aboard of our little schooner and scud back to harbor amid the breaking waves and chilling blasts of a winter gale. My observations therefore cover a very small period of time,—*i.e.*, from the 1st to the 4th of December. This proved to be the time of parturition among the seals, for upon making a landing on the east island we killed a female with a fœtus nearly ready for birth, and in a little internal pond of salt water found a female lying on her side suckling her young. She paid no more attention to our near approach than would the familiar denizens of the barn-yard under similar circumstances. Subsequently four other females were killed containing nearly ripe fœtuses. In one case, where the fœtus was removed immediately after killing the mother, it kicked and squirmed for one or two minutes in such a lively manner as to indicate that delivery would have occurred in a few moments had the female not been molested. Following the usual order with seals, there is but one offspring at a birth. The female can have little difficulty in nursing this, as in any but a perfectly prone position one or more of her four teats will always be within reach of the young.

The fœtus is quite large, one measuring 85 c.m. in length from tip of nose to end of tail.[1] The hair is long, very soft and woolly, and of a glossy black color. Parturition probably occurs in shallow water, as the three females noted nearest this period were lying stranded on the beach, half in and half out of water.

The young seal previously mentioned was of a uniform black color, including its mystacial bristles, with large, dark brown, lustrous eyes that looked inquiringly at one: more intelligent in appearance than were the adults. This youngster we took with us on leaving the islands, and had it in captivity for a week or more at Campeche, where it eventually died, probably from lack of proper nourishment.

Its teeth were uncut, and so it had no thoughts of offering

[1] More measurements and descriptions of this seal will be found in a bulletin of the American Museum of Natural History, now in course of preparation by Professor J. A. Allen.

resistance when handled. It was totally devoid of fear; but most too young to make any demonstrations of friendship. Its time on shipboard was spent in aimlessly roaming to and fro, serenely regardless of such trivial obstructions as people standing in its way; uttering every few moments its cry, a long drawn out, guttural "ah," with a series of vocal hitches during its enunciation. At Campeche this little seal seemed to enjoy its daily bath in the sea, plunging its head under water and blowing and snorting as if in great glee, yet ever and anon uttering its plaintive cry, as if in momentary mourning for its lost parent.

Two females containing fœtuses measured respectively 2 m. 16 c.m. and 1 m. 99 c.m. from end of nose to end of tail. Two adult males measure from a skeleton and stuffed specimen respectively 2 m. 29 c.m. and 2 m. 16 c.m. between the same points. These are about the maximum sizes, of the two sexes, noticed. Such a seal looks large and might easily give rise to the "about ten feet in length," and even greater measurements, that have been reported of this species.

From the black pelage of the extremely young to that of the adult there is an intermediate stage of yellowish gray on the dorsal surface, shading to almost a perfect ochre on the ventral portions. Adults are grayish brown or grisled on the back, a result of the Vandyke-brown hairs being tipped with light horn-color, the lower surface ochreous-yellow to yellowish white. Females seem to have much less of the yellow or white on the ventral surface.

The variations in coloration in individuals of approximately the same age seemed to be comparatively slight. In adults the mystacial bristles vary from dark horn-color for the basal half and light horn or whitish for the remainder, to a clear light color for their entire length. They taper gradually to a remarkably fine point, for a half-inch, in some specimens, being scarcely heavier than a coarse human hair.

The head is very large and prominent, having an extremely "brainy" appearance even for a seal: quite belying its mental capacity, which seems to be very slight. This prominence is not so much on account of the size of the skull as because of the immense amount of muscle and flesh intervening between it and the skin. The whole body of the animal is very chunky. The bones are all deeply embedded in the flesh, over which, particu-

larly on the belly, lies a thick coating of fat. The eye of the adult is an index to its mental capacity, for so dull is it that in the first specimen observed I was much inclined to think that this organ was diseased. The pupil is medium-sized, round, and well defined, the iris is light reddish brown in color, and with but little of the sclerotic coat showing. Over the cornea there appears a deadening film, giving it much the same appearance as a glass eye or marble that has been so much handled as to lose its polish. May not this lustreless eye arise from the strong reflection of a tropical sun upon the coral sands? Most seals have a peculiarly soft, intelligent eye.

When lying with the head close to the ground, either in life or immediately after death, the shoulders appear more prominent than in any other seal with which we are familiar.

The whole character of this seal is that of tropical inactivity, exemplified by the peculiar circumstance that several of those collected had such a growth of minute algæ upon their backs and flippers, more especially the hinder ones, as to appear quite green. At no time does this seal raise its head as much above the line of its back as does the harbor seal: the flexibility of its cervical vertebræ appearing to be quite restricted. Upon first approaching them they appeared to have no dread whatever of the human presence, lazily looking at us, perhaps uneasily shifting their position, and then dozing off in restless sleep. Upon advancing to within three or four feet they would somewhat rouse themselves, bark in a hoarse, gurgling, death-rattle tone, and uneasily hitch themselves along a few paces. At first the seals offered very little resistance, and only upon the second day of our stay, when they had become somewhat accustomed to our presence, and when we made an onslaught upon a group of several, did they show fight at all. On this occasion their numbers and their being huddled together seemed to give them courage, as well as making our attempts to kill them with clubs and daggers (we had early decided not to use firearms, because of the danger of frightening them away from such small islands) dangerous and more or less abortive. Not infrequently would they make savage rushes for a yard or two at some one of our attacking party, and failing to reap revenge upon us would fall upon their dead or dying fellows, biting and shaking them in impotent rage; or occasionally two would engage each other in

savage conflict for a moment or two, the heavy gnashing of their teeth as their powerful jaws closed giving us a lively idea of how unpleasant it would be to fall within their reach. Nevertheless, the whole aspect of the animals was one of indecision. Instead of stampeding when molested, they only roused themselves to action upon being individually attacked. As another illustration of their lack of intellectual acuteness, I may mention that on the following morning we found several seals that had "hauled up" during the night among the dead ones surrounded by skinned carcasses.

In the water they showed no particular curiosity in regard to a boat or its occupants, a curiosity usually so very marked among seals, nor did they disport themselves in play as does the harbor seal. That they are generally peaceful is borne out by their appearance, very few scars of combat being observed, and some of these not unlikely inflicted by the myriads of sharks surrounding the islands. The contents of the stomachs of several were examined, but nothing except fluids were found, which gave no clue to their food. It undoubtedly consists largely of fish: one in captivity was fed on this food and appeared to thrive well. They are greatly infested with intestinal parasites several inches in length, that shortly after death swarm out of anus and vagina, dying as they reach the air. On land or in shallow water the seal progresses by drawing forward the hind parts, thus throwing the line of the back into a strong curve, then pitching itself forward on to its breast to again repeat the same action. The distance covered is usually about a foot, the difference between the chord of the arc and the horizontal length between the fore and hind flippers; but when this movement is violent the seal throws itself forward with so much force as to somewhat overshoot this. The appearance of one moving is much like that of an "inch-worm,"—a continual bobbing up and down of the middle of the back. One was noticed that, when under considerable excitement, evidently forgot how to run, but lay on its belly trying to scull through the sand with its hind flippers as though it were in the water.

On the 29th of November last a small seal was captured alive near the city of Campeche; but as we were busy getting away we did not obtain it. On our return the purchaser tried to dispose of it to us for one thousand dollars! and on my departure for

the north still held it at two hundred dollars. It was difficult to glean any exact data from the inhabitants; but I am inclined to believe that the seal is quite uncommon on the coast. The high price asked for the young one, and the fact that it was here placed on exhibition and afterwards taken to Progresso for the same purpose, would seem to confirm this.

About forty years ago, I am told, a vessel was wrecked at the Triangles, the captain and a negro, the only survivors, living upon seals and birds for six months before effecting their escape. Mr. W. B. Alexander, of Plymouth, Mass., writes me, under date of February 9, 1887, "In the spring of 1856 I was with Captain Lucas at the Triangles for a load of Mexican guano. I only saw two seals while there, which left the island in a hurry, so I can give you no information from personal knowledge, although there must have been great numbers there, by the skeletons, poor hides, etc.; and some one must have carried on an extensive business in that line, for we made a grand bonfire of perhaps a hundred barrels of the remains."

Mr. F. A. Lucas writes me from the United States National Museum, February 2, 1887, "In the spring of 1856 my mother was at the Triangles, where my father, A. H. Lucas, had gone in the bark 'Edwin,' of Charlestown, Mass., to seek guano. The young boobies were in downy plumage, and this is why I call it spring. My mother remembers seeing seals on the rocks, and seal-bones were found on the island."

Mr. Gosse, "A Naturalist's Sojourn in Jamaica," says that this seal has crimson irides, that "the hair prevails everywhere except on the palms of the flippers, which are bare," and "the color of the body is an intense uniform black." The first two points are evidently mistakes. The third is characteristic only of very young specimens of Monachus. Perhaps it is Gray's *Cystophora antillarum*, a species concerning which I am very sceptical.

But color seems to be a great stumbling-block with many. Mr. H. W. Elliott, usually so exact in description, in *Science*, vol. iv. pp. 752, 753, describes the specimen now in the National Museum as "intense ebony-black," while Messrs. True and Lucas, in Smithsonian Report, 1884, Part II., p. 332, in describing the same specimen, say, "In our specimen the hairs of the back and hind flippers appear light at the tips, as if faded by age; but are dark sepia color or nearly black, except at the extremity."

It is surprising how this seal has lived for so long a time in such a frequently traversed part of the ocean as the Gulf of Mexico, surrounded as it is on all sides by populous cities, and yet should for nearly four hundred years remain all but unknown. Naturalists are usually particularly acute in searching out rare specimens; but by some peculiar combination of circumstances this seal has eluded the many scientific expeditions heretofore made to these waters.

For a full description of this seal the reader is referred to the previously-mentioned bulletin of Professor Allen, to whose much more able hands this work peculiarly belongs, and to whom I have willingly resigned it.

EDITORS' TABLE.

EDITORS: E. D. COPE AND J. S. KINGSLEY.

WE most heartily approve the growing practice of using English names for the various fungi, especially those which are of interest to us economically. Such fungi must be discussed over and over again in the journals of the day; they must be talked about by farmers, gardeners, stock-growers; they must be described by teachers and popular lecturers. A few of these species which are bound to have this publicity have scientific names which can be readily adopted into English speech; but in the great majority of cases the scientific names cannot be used by the people, nor can they be in any way "anglicized" or modified into such forms as will bring them into every-day use. Thus, while the genus Bacterium has given us the accepted term Bacteria for a group of organisms, the allied genus Saccharomyces has not been nor ever will be anglicized. Possibly Mucor may come into common use, but Entomophthora never will; nor will Phytophthora, Podosphæra, Sphærotheca, Microsphæra, Erysiphe, etc. It is not too much to hope that gardeners will habitually speak of the "Ramularia" of the strawberry, the "Septoria" of the plum leaf, the "Peronospora" of the grape-vine, but is any one rash enough to expect to hear our vineyardists speaking familiarly of the Physalospora ("Black Rot"), the Cercospora ("Grape-leaf Blight"), or the Phyllosticta ("Grape-leaf Spot")?

English names, or names which can be readily used by English-speaking common people, must be devised by our writers upon the injurious fungi. But in order that confusion shall not arise among and be propagated by the botanists themselves, it is all-important that English names should be chosen with the greatest care. Several years ago this matter was talked over in the Botanical Club of the American Association for the Advancement of Science, and it was hoped that some good would come of it, but no report has yet been made by the committee then appointed.

Let us have, before the confusion proceeds further, a clear understanding among botanical writers as to the application of the terms Blight, Mildew, Rust, Smut, Scab, etc. Let the fungi of certain orders bear certain English names. Let us say "the Rusts" for the Uredineæ in general, and Wheat Rust, Maize Rust, Euphorbia Rust, Rush Rust, Bean Rust, etc., for the species. Let us no longer use the name "Rust" for other fungi. It is doubtful whether the use of a modifying term ought to be encouraged in the English names of groups, as, for example, the "Downy Mildews" for the Peronosporeæ, and the "Powdery Mildews" for the Perisporiaceæ. This compels us to use terms like "the Powdery Mildew of the Lilac," "the Downy Mildew of the Grape," etc., forms of expression which are not likely to become common.

There is opportunity here for the exercise of considerable ingenuity among our students of the fungi. In constructing such English or anglicized names, that most excellent rule, "Avoid very long names as well as those that are difficult to articulate" (Laws Bot. Nomen., Art. 36), should be strictly observed.—*C. E. B.*

A Louisiana planter, according to the public press, is importing a load of rabbits from Australia, for the purpose of stocking a game-preserve with that animal. The extreme fecundity of this species (*Lepus cuniculus*) is well known, and in Australia its introduction from England has done incalculable harm to the agricultural interests. Hence the Louisiana enterprise is looked on with considerable anxiety by some persons.

The prospective injury will depend on the management of his preserves by their owner. The Australian fauna is peculiar in

the absence of carnivorous mammalia, and hence the increase of rabbits, kangaroos, etc., has little natural check excepting that of deficient food-supply. In the United States the case is far different. Here the opossum, raccoon, several species of weasels, foxes, and cats furnish an effective restriction to the increase of any form of animal life sufficiently large to attract their attention. If the keepers will permit the presence of these carnivora in the preserves there need be no fear of excessive increase of the rabbits, and quite a zoological garden might in this way be maintained.

RECENT LITERATURE.

Vines's Physiology of Plants.[1]—This important work has been before the scientific public for somewhat more than half a year, and has in that time received the critical attention of most of the vegetable physiologists. It has already taken its place as an admirable cyclopædia of vegetable physiology, from which the botanical lecturer can draw *ad libitum* in the preparation of his notes. This use of the book is much favored by its form, the various topics being treated in twenty-three "Lectures." With the exception of the tables, which in some parts of the book are pretty freely used, there is little in it to remind one of the usual text-book. The style is eminently that of the lecturer before an audience, and, while it is pleasant to read, one cannot help thinking that it might have all been given in the book in much less space. There is a notable absence of any indication of the scale upon which the figures are drawn in the illustrations, an oversight which we attribute to the emphasis of the "lecture" idea in the book.

The general sequence of subjects may be understood from the headings of the successive chapters, as follows: the structure and properties of the plant-cell; absorption, the movement of water in plants; transpiration, the food of plants; metabolism, growth, irritability, reproduction. In some cases several chapters or lectures are given to each topic; thus "irritability" is discussed in seven lectures, covering 226 pages, or very nearly one-third of the book.

In a work of this kind one may demand exactness of statement and a freedom from contradictions. It is puzzling to the reader to be told on page 22, that "in some cases it is evident

[1] Lectures on the Physiology of Plants. By Sidney Howard Vines, M.A., D.Sc., F.R.S., Fellow and Lecturer of Christ's College, Cambridge, and Reader in Botany in the University. Cambridge, at the University Press, 1886, pp. x., 710. With 76 figures in the text.

that the incrustation (on the surface of plants) has been formed by the evaporation of water holding the salt in solution, which had been excreted by the plant;" while on page 60 it is said that "there is no evidence to prove that a plant loses any of its mineral substances which it absorbs." In the table on page 106 the relative numbers of stomata upon the two surfaces of the leaf of the Lilac (*Syringa vulgaris*) are given as 100 for the upper, 150 for the lower surface, an error which is the more notable from the fact that the figures in the following column ("relative quantity of water transpired") lose their significance when brought into relation with the proper numbers (0 for the upper, 330 per square mm. of the lower surface).

On page 599 we notice with pain the careless use of the word "bud," in speaking of the soredia of lichens. The use of words in this loose way in a scientific work can be productive of bad results only. A bud is one thing, a soredium is an entirely different thing. On pp. 602 and 603 we find another batch of loose statements, from the description of the mode of spore-formation in Bacillus to the remark that "the teleutospores of these fungi [Uredineæ] are those which are formed in the autumn, at the close of the growing season."

In spite of these blemishes and imperfections, the book is one calculated to do much to elevate the botanical work of the schools and colleges, and we trust that in this country its spirit and influence may be abundantly felt.—*Charles E. Bessey.*

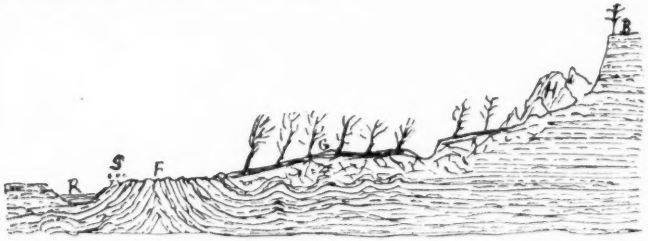
GENERAL NOTES.

GEOLOGY AND PALÆONTOLOGY.

A Landslide at Brantford, Ontario, illustrating the Effects of Thrusts upon Yielding Strata.—A landslide along the right bluff of the Grand River, about two miles southeast of Brantford, Ontario, which occurred at 6.45 P.M. of April 15, 1884, is worthy of notice as giving not only one of the best known illustrations of the structure of the Erie Clay of Ontario, but as showing the physical effects upon a smaller scale of lateral thrusts upon yielding strata.

At the point where the slide occurred the valley is about two miles wide, although some distance above and below it is much narrower. The sides of the valley rise about ninety feet above the flood plain, which is ten feet above the usual surface of the river. The upper twenty feet are composed of sandy Saugeen Clay (of Canadian geologists), in very thin regular beds, whilst the lower portion of the cliffs and that below the modern alluvium

consists of Erie Clay. None of the underlying rocks of the Upper Silurian series are exposed. Owing to weathering, the surfaces of the Erie Clay soon cease to show their stratification. But here, after the slide, the great hummocks and pyramids—some ten feet or more in height, with bases as great or greater—have been bodily thrown out in great quantities, owing to the finely-jointed structure rarely shown in natural sections or artificial cuttings. The joints are mostly oblique to the bedding, yet some are perpendicular. These pyramids are composed of indurated beds of fine clay in layers of only an inch or two in thickness, easily splitting into slabs. The landslide, in this material, extended along the face of the bluff for seven hundred feet. A belt, eighty feet wide, was detached from the brow of the table-topped cliff, and in sinking sixty feet, caused the forward movement of a mass two hundred and forty feet wide, and anywhere from twenty-five to forty feet thick, between the lower part of the hill-side and the river, as shown in the diagram, which is across the western end of the slide.



R, bed of river; S, stones lifted by thrusts from bed of river; F, folds produced; G, grassy slope moved forward; H, hummocks from the face of the bluffs, B. Scale, one hundred feet to one inch.

Owing to the forward movement and reaction, the deposits of the Erie Clay have been raised into perfectly truncated anticlinal folds, which are composed of vertical strata more or less twisted. The vertical edges, where not concealed, are forty-four feet across, and on them—ten feet above the surface of the river—are resting the pebbles of the former bed of the stream now elevated.

Adjacent to the vertical strata at the western end of the slide rest the transported, but otherwise almost undisturbed, grassy sloping surface, with the trees still standing, but sloping at angles from twenty-eight to thirty-five degrees from the perpendicular towards the hill, as the present slope is that of a surface which formerly stood farther up the hill-side, at a higher angle. The junction of the former steeper and lower inclinations is now marked across the transported grassy surface by a deep longitudinal fissure. The eastern end of the slide consists only of a confused mass of hummocks and pyramids.

The landslide was due not to any undermining of the bluff, as the inclination of its lower part was at too low an angle, and the river two or three hundred feet away, but due to the hydrostatic pressure acting in the joints and along the smooth bedding of the clay, wherein the cohesion was reduced so as to allow the sinking of the brow of the bluff, and pushing forward a mass whose total volume was from half a million to a million cubic feet.

This landslide might almost be regarded as a gigantic laboratory experiment on plications, twistings, and thrusts, as shown in folded schistose rocks of mountain regions.—*J. W. Spencer, University of Missouri, Columbia, Mo.*

Age of the Niagara River.—The visit in August last of the Geological Section of the American Association to St. David's Valley,—adjacent to the Whirlpool of the Niagara River,—has drawn forth some notes upon this subject in the issues of *Science* for September 3 and 10, 1886.

In my various articles bearing upon the origin of the Great Lakes,—the most recent of which appeared in "Surface Geology of the Region about the Western End of Lake Ontario," *Canadian Naturalist*, 1882,—after having shown that the deep western end of Lake Ontario was due to subaerial erosion and streams, —among which was a great river flowing from the Erie Basin, with large tributaries from the highlands of the province of Ontario, cutting a cañon through the thick beds of limestones and shales of the Niagara escarpment to a depth of nearly one thousand feet—now partly submerged beneath Lake Ontario—and a width of over two miles,—I accounted for the drift-filled valley of St. David as being a portion of a channel of an interglacial Niagara River.

Subsequent observations of Dr. Julius Pohlmann (Proc. A. A. A. S., 1882) show that the eastern end of the Erie Basin is due to erosion by streams,—some of whose channels are now deeply buried near Buffalo,—which emptied into the Alleghany River, as it flowed northward from near Dunkirk, into the western end of Lake Ontario by the Dundas Valley. This great ancient water-way is now partly filled with drift, and is still more obscured by the warping of the rocks along the anticlinal between the two Great Lakes.

Upon further examination it will be found that the St. David's Valley is small, not only when compared with the great (Dundas) valley,—the old outlet of the Erie Basin,—but even with many other valleys cutting into the Niagara escarpment. Again, Professor Claypole's observation that rocks are found beneath the talus at a considerable height along the sides (at least) of the buried valley at the Whirlpool, restricts still more its probable depth. In short, the St. David's Valley is inadequate for the drainage of a great basin like that of Lake Erie.

Not even was the ancient representative of the upper portion of the Niagara River, above the Falls, of sufficient depth to drain Dr. Pohlmann's Buffalo Creek, for it flowed in a channel at least eighty-three feet beneath the present surface of Lake Erie, whilst the adjacent ice-scratched bed of the Niagara River, at the Buffalo International Bridge, is not more than forty-five feet beneath the lake surface.

Consequently, it appears that the St. David's Valley and such portions of the channel as those ice-scratched above the Whirlpool which remain, represent only the water-course or water-courses of local drainage before the Ice Age. This being the case, the ancient river did not recede deeply into the Niagara escarpment, and we are led to the conclusion that the cañon of the Niagara River, above the Whirlpool as below, is mostly of modern origin throughout, and not to any great extent an ancient drift-filled gorge, re-excavated since the Ice Age.—*J. W. Spencer, University of Missouri*, November, 1886.

Palæontological Observations on the Taconic Limestones of Canaan, Columbia County, N. Y.[1]—These researches occupied a little more than two days in June of this year, and were made in continuation of those previously reported, with the following results:

I. Thorough search was made in and around the farm of E. S. Hall, near Flatbrook, with the hope of finding in place the Trenton limestone which occurs here in large loose angular masses, filled with *Solenopora* (*Chætetes*) *compacta* and other minute corals. A ledge was found which may very likely contain altered nodules of this coral, but no positive evidence of its presence was obtained. The fossiliferous masses may well have come from ledges concealed under the deep drift which covers this farm.

II. An exceedingly interesting locality of richly fossiliferous limestone was discovered about two and a half miles to the north of Hall's farm. It is on the farm of Mr. Joseph Heminway, about a mile and a quarter northeasterly from the Canaan Four Corners Railway Station; it barely crops out at the surface, at the eastern foot of a very conspicuous limestone ledge lying immediately east of the farm buildings. Much of this rock is a mass of organic remains, most of which are finely comminuted fragments of crinoid columns mixed with portions of mollusc shells.

Though presenting a somewhat different set of the larger organisms, this stratum appears most probably identical with the fossiliferous limestone at the Canaan railroad tunnel, described in the *American Journal of Science* for April, 1886. The Hem-

[1] Abstract of paper presented before the American Association for the Advancement of Science, at Buffalo, August, 1886.

inway outcrop is, however, much the richer in fossils, of which the following have already been collected:

1. Crinoidal fragments in vast numbers.

2. Fragments of lamellibranchs, perhaps of the genus Lyrodesma.

3. Gasteropods of several genera and species. One of these is apparently a Holopea. Two or three other species which are very conspicuous on weathered surfaces have low spires and numerous whorls; some of these are from one to two inches in diameter, and have six or seven whorls. They look exceedingly like Ophileta, but may prove on careful examination to be Helicotoma or Pleurotomaria.

4. A single genal spine of a small trilobite.

There were found also, large calcareous plates, whose precise nature is not evident.

The general character of these organic remains indicates very decidedly the post-Cambrian origin of the strata; while, in spite of the Ophileta-like appearance of some of the Gasteropods, the presumption is strong that they belong to the Trenton epoch.

NOTE.—Subsequently to the presentation of the above paper, the continuation of these investigations at Canaan developed yet more important facts. In a limestone ledge on the Heminway farm, lying a little east of the fossiliferous outcrop above described, indications of Orthocerata were noticed; on following this outcrop northward a few hundred feet into the farm owned by Professor Charles Drown, quite a number of very interesting Orthocerata were discovered. These are finely preserved and distinctly characterized, showing admirably the septa and siphons. One of these is very nearly one foot long, and its shell is quite cylindrical, since the taper is exceedingly gentle. The septa in all are quite frequent, about fifteen to twenty to the inch. A well defined lituite was also found here.

These Orthoceratites are of the same general type as those occurring at Rockdale, near Poughkeepsie, N. Y., which from their character, and from their associate fossils, I consider as belonging to the horizon at present known as the Calciferous.

This, and the Trenton, therefore, appear to be associate components of the Canaan limestones.—*Wm. B. Dwight.*

MINERALOGY AND PETROGRAPHY.[1]

Volcanic Bombs.—In view of the fact that the volcanic bombs of Monte Somma present such a large variety of beautifully crystallized minerals in druses, and further, that in the case of the limestone bombs these minerals may well be supposed to owe their origin to the action of the hot lavas on pieces of limestone torn from the walls of the vent through which the lavas reached

[1] Edited by DR. W. S. BAYLEY, Madison, Wis.

the surface of the earth, it is a matter of no little surprise that sections of these bombs have not been more thoroughly investigated by means of the microscope and the other appliances now so generally made use of in the attempt to discover the origin of rocks and minerals. The most satisfactory article which has thus far appeared on this subject is that of Bruno Mierisch,[1] working under the supervision of Professor Zirkel at Leipzig. Eighty specimens of these bodies belonging to the collection of the University of Leipzig were examined. As might be expected, the results reached are exceedingly interesting. According to Mierisch the bombs may be divided into two great classes: (1) those consisting of broken pieces of older lavas, which are included in the younger lavas, and (2) the limestone or silicate bombs, in the druses of which the crystallized minerals, as mentioned above, are found. It is to the latter class that the present writer confines his attention. This class can be subdivided into limestone bombs and silicate bombs, and the latter of these again into (1) those in which the minerals are zonally arranged, and (2) those in which this arrangement is wanting. Under the microscope the limestone bombs are seen to consist of grains of calcite and an olivine mineral, which analysis proves to be forsterite, —the pure magnesium olivine. A noteworthy fact in this connection is the entire absence of even a trace of calcium in the forsterite, and the existence of the merest trace of magnesium in the closely-associated calcite. When druses occur in these limestone bombs their walls are formed of successive layers of magnesium mica (meroxene) and augite, upon the second of which the true druse minerals appear. With the increase in the size of the mica and augite zones the limestone bombs pass gradually into the zonally arranged silicate bombs, which consist of successive zones of olivine (mixed with a few grains of calcite and spinel), mica, and augite, upon the latter of which again the druse minerals proper are found. The second class of silicate bombs, to which belong the well-known sanidine bombs, is composed almost entirely of minerals found only in the druses of the limestone and zonal silicate bombs, and hence are probably merely druse fillings.

After treating in a general manner of the structure and classification of these bodies, Mierisch takes up separately each mineral occurring in them, and describes in detail its appearance, microscopical characteristics and associations. Here again we find many items of exceedingly interesting information, only the most important of which can be noticed. In the calcite of the limestone bombs glass inclusions were detected. These, according to the author, cannot be considered as secondary in origin, because not a trace of glass was detected in the ground-mass of any section examined. Consequently the calcite must have

[1] Tschermak's Min. u. Petrogr., Mitth. viii., 1886, p. 114.

included these in its crystallization from a molten magma. Porphyritic biotite crystals were seen to be surrounded by a rim of little augite crystals, evidently an alteration product, since in the immediate vicinity of the augite the biotite was bleached. In the olivine, fluid inclusions containing crystals of salt were detected. In some of the hauyne crystals inclusions of pyrrhotite were observed. It was noticed that as decomposition of these inclusions proceeded the substance of the hauyne became of a deeper blue color. The inference drawn by the author is to the effect that the sulphur freed by this decomposition is the agent which produces the blue coloration.[1]

Petrographical News.—About a year ago reference was made in these notes to the work of Hatch[2] on the andesites of Peru. The same author has continued his work, and now appears with a paper[3] on the rocks of the volcanoes in the neighborhood of Arequipa, a town in the southern part of Peru, about twenty miles from the Pacific coast. These rocks consist of andesites in all varieties, from the typical hornblende andesite, through intermediate varieties, to the rock containing augite as its only bisilicate constituent. Hypersthene occurs very widespread in the lavas of all the volcanoes in this region. Particular pains were taken to identify this mineral in a manner to preclude the possibility of error, and it was found that the only reliable means of distinguishing it from monoclinic augite consisted in the determination of the position of the optical axes. In almost every case where hornblende was present it was found to be surrounded by an opacitic rim, outside of which was occasionally seen a second rim of augite microlites. The high percentage of silica noticed in certain of the specimens was proven to be due to the silicification of the rock by the impregnation of its constituents by opal.——The Ponza Islands, off the west coast of Italy, are comprised[4] principally of trachytes, rhyolites, and tufas. An interesting point in connection with the trachyte of the island of Ponza is the occurrence of olivine in it. Glaucophane is supposed to occur in that of San Stefano. The tufas contain pebbles and pieces of quartz in addition to the broken crystals of various minerals. The ground-mass of the quartz trachyte from San Pietro,[5] off the southwest coast of Sardinia, consists of chalcedonic substance, in which are grouped little fibres of chalcedony in radial aggregates. Rhyolite, obsidian, and perlite are also found there.——In the diabase porphyrite from Petrosawodsk,[6] in Russia, about three hundred miles northeast of St. Petersburg, the porphyritic feldspar crystals are composed of parallel growths

[1] *Cf* Vogelsang, Ueber natürliche Ultramarinverbindungen.
[2] American Naturalist, February, 1886, p. 161.
[3] Mineralog. u. Petrog., Mittheil. vii., 1886, p. 308.
[4] F. Eigel, ib., viii., 1886, p. 73. [5] Ib., p. 62. [6] C. v. Vogdt, ib., p. 101.

of oligoclase, labradorite, and orthoclase. These crystals, moreover, have undergone an unusual alteration into an aggregate of colorless prismatic needles of a uniaxial mineral, which occur either radially grouped or scattered indiscriminately in the mass of their otherwise apparently unaltered host. Their nature could not be determined, but an analysis showed that the alteration is attended with loss of silica and potassium and addition of aluminium. The ground-mass of the rock contains numerous little plagioclase crystals and grains of epidote, which v. Vogdt thinks were derived from the substance of the ground-mass by hydro-chemical processes.——Certain conglomeratic, granitic, and felsitic rocks occurring in Pembrokeshire, England, which Mr. Hicks[1] thinks are pre-Cambrian in age, have recently been described by Bonney.[2] The so-called felsites from Trefgarn are, according to this author, hälleflintas of volcanic origin, consisting of acid lavas and their associated ashes, which have been permeated by hot water, containing silica in solution, and have thus been silicified by the replacement of their feldspathic constituents by chalcedonic quartz.——The greenstones of St. Minver, Cornwall, have been separated by Rutley[3] into two distinct varieties. The first embraces those rocks which were once glassy basalts or andesites, but which have undergone decomposition with the production of bands and "small knots" of felsitic material, separated by bands of serpentine or palagonite. In the felsitic portion are small circular and lenticular areas of quartz and serpentine, which the author regards as the fillings of original vesicles. The second class described is of much fresher rocks. These contain large areas of augite, polarizing as a single individual, in which are included small crystals of plagioclase. [This same structure has been described frequently by American petrographers[4] under the term "lustre-mottling" (Pumpelly and Irving) and "poicilitic structure" (Williams).] Aggregates of augite, plagioclase, ilmenite, and a few accessory and secondary minerals make up the entire rock. The author calls it an augite-andesite.——In an appendix to an article by Mr. Durham[5] on the volcanic rocks of Fife, Professor Judd describes altered augite and enstatite andesites, in which the porphyritic pyroxene crystals occur in groups, and also porphyritic and perlitic mica-dacite glasses. In the base of the latter feldspar microlites and trichites are arranged in flowage lines. When heated before the blow-pipe a splinter of this rock lost 8.9 per cent. of its weight, and attained a bulk eight or ten times as great as that of the original fragment, producing a pumice which readily floated on water. The author concludes his paper with a dis-

[1] Quart. Jour. Geol. Soc., xlii., August, 1886, p. 351.
[2] Ib., xlii., August, 1886, p. 357. [3] Ib., xlii., August, 1886, p. 392.
[4] *Cf.* American Naturalist, March, 1886, p. 275.
[5] Quart. Jour. Geol. Soc., August, 1886, p. 418.

cussion of the several stages in the alteration of pyroxene andesites, as illustrated by the specimens examined. In the case of the mica-dacite glasses, alteration begins along the perlitic cracks, when it produces globiform masses, and then gradually extends outward until the entire body of the rock becomes white and opaque and appears to be isotropic. The author thinks that this alteration product may be a hydrated acid glass, corresponding to the palagonite of basic rocks.——In a recent article in which are given the results of the analyses of many of the phyllites and of the sericite, ottrelite, and hornblende schists of Belgium, Klement[1] says that the laterite from the Congo is a conglomerate consisting of sandstone pebbles cemented by limonite or some other hydrated oxide of iron.——In a letter to the *Neues Jahrbuch für Mineralogie*, Siemiradski[2] describes three anorthite rocks from the island of St. Thomas, one of the Antilles. One is a corsite with a ground-mass saturated with secondary opal, which has been produced by the decomposition of the other constituents. The other two are dyke rocks cutting the corsite. They can be best characterized as altered anorthite andesites.

Mineralogical News.—The optical investigations of Langemann[3] on harmotome, phillipsite, and stilbite seem to indicate that these three minerals are triclinic in crystallization instead of monoclinic as has heretofore been supposed. According to this view the twinning laws of these minerals are: (1) twinning planes $\infty P\breve{\infty}$ and OP, giving rise to interpenetration fourlings with an orthorhombic symmetry; (2) two fourlings twinned according to the plane $P\breve{\infty}$ produce eightlings, with a quadratic symmetry; and, finally (3), three eightlings with ∞P as their twinning plane yield twenty-fourlings with a regular symmetry.——By observing the forms of the figures which are produced on the cubic faces of sylvite, when it is exposed to the action of moist air, R. Brauns[4] has succeeded in showing that the crystallization of this mineral is like that of cuprite and salammoniac, in the gyroidal hemihedral division of the regular system. The bromide and the iodide of potassium crystallize similarly.——In a late number of the fourth Beilage Band of the *Neues Jahrbuch für Mineralogie* H. Schedtler[5] has an elaborate paper on the thermo-electrical relations of tourmaline. The paper opens with an historical introduction to the subject, in which the results of many earlier investigations are given. Then follow descriptions of the methods in use for the detection of electricity in minerals, and some general considerations, after which the author describes his own results based upon the examination of sixty-

[1] Min. u. Petrogr., Mitth. viii., 1886, p. 1.
[2] Neues Jahrb. f. Min., etc., 1886, ii. p. 175.
[3] Ib., p. 83. [4] Ib., vol. i. p. 224.
[5] Ib., Beil. Band iv., 1886, p. 519.

seven crystals, from almost every known locality in which this mineral is found. These results are embraced under fifteen heads. Under one of these he states that the electrical activity is greater in the green, brown, and red crystals than it is in black or colorless ones; and that the black crystals often show no electrical phenomena, but, on the other hand, are conductors of electricity. ——The same subject has been treated in a paper by E. Riecke in the *Annalen der Physik und Chemie*.[1]——In his study of Brazilian topaz K. Mack[2] has found that the electrical axis does not correspond to any crystallographic axis, and that in cases where the crystallographic axis does not exactly bisect the optical angle, this anomaly is accompanied by abnormal extinctions in the plane of the optical axes.

BOTANY.[3]

The Study of Plant Diseases.—Although the fungi themselves have been studied in this country for many years, the diseases they produce have hitherto received little attention. One would have supposed that from the thirty or forty agricultural colleges and agricultural departments of colleges in the United States something might have come, but the returns from these institutions have been as meagre as from other sources. Doubtless one great reason for this barrenness of results has been the want of time on the part of the professors of botany. With the burden of many classes always upon them, and often the almost total absence of collections, books, and instruments, the professor of "science" has had indeed a hard road, and it is a cruelty to blame him for not being productive. But with these allowances, it must be confessed that botany is often taught by men almost wholly unacquainted with the subject. It is by no means an unusual thing to find professors teaching botany whose knowledge of the subject stops short of the ability to handle the Compositæ. The Grasses and Sedges, to them, are little better than "Cryptogams," and as to the latter, they are simply Cryptogams. From such botanists no study of plant diseases need be expected.

Two recent publications ought to direct the attention of our botanists to this much-neglected field. Mr. Arthur's report, as botanist of the Agricultural Experiment Station at Geneva, N. Y., shows where and how good work may be done by those competent to do it. Among the topics taken up are Pear Blight, Rotting of Tomatoes, Mildew of Strawberries, Plum-leaf Fungus. Aside from its economic value, the report is valuable as indicating better methods of work in botany. Let any one read over the pages treating of the Pear Blight, and he cannot help feeling that the work there recorded is of a much higher order than that

[1] No. 5, 1886, p. 43. [2] Annalen der Physik und Chemie, No. 6, 1886, p. 153.
[3] Edited by Prof. CHARLES E. BESSEY, Lincoln, Nebraska.

usually considered as belonging to the botanist. The work here recorded is entitled to be called strictly scientific.

The second publication is Mr. F. L. Scribner's "Fungus Diseases of the Grapevine," issued by the Department of Agriculture at Washington, D. C. Its principal contents are the Downy Mildew (*Peronospora viticola*), Powdery Mildew (*Uncinula spiralis*), Black Rot (*Physalospora bidwillii*), Anthracnose (*Sphaceloma ampelineum*), Grape-leaf Blight (*Cercospora viticola*), Grape-leaf Spot (*Phyllosticta labruscæ*). Some good plates accompany the text, and add much to its value. As with the preceding report, this one ought to show our younger botanists that there is an opportunity for them to do good work in botany even.—*Charles E. Bessey.*

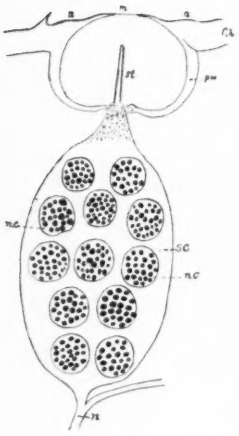
Vegetable Pathology.—Agriculture demands of botany a knowledge of the pathology of vegetation. It is not enough that the normal action of all parts of the plant should be understood; the abnormal and diseased actions must also be considered. Unfortunately, the world is full of accidents, of noisome gases, of poisonous liquids, of freezing or scorching temperatures, of harmful insects, and of destructive fungi. The plant which is more or less affected by one or all of these is not the normal plant of the vegetable physiologist. The vegetable pathologist must build his science upon that of his fellow-worker in vegetable physiology, and the results of the labor of both must be laid before modern agriculture for its use. That botany which hopes to satisfy the demands of the advanced agriculture of to-day must include a knowledge of pathology.—*Proc. Soc. for Promotion Agr'l Sci.*

Botanical News.—From Dr. A. N. Berlese we have a paper on a new Pyrenomycetous genus, Protoventuria, represented by a single species, *P. rosæ* Berl. (=*Venturia rosæ* De Notaris). A good plate accompanies the paper.——The old genus Phoma has been divided, and a new genus, Macrophoma, has been erected by Doctors Berlese and Voglino (*Atti della Societa Veneto-Trentina di Scienze Naturali*, vol. x.). The new genus also includes species formerly referred to Sphæropsis and Sphæronema. Ninety-nine species are enumerated, twenty-one of which are figured upon the accompanying plates.——Doctors Berlese and Voglino have published a volume of Additamenta to Volumes I. to IV. of Saccardo's "Sylloge Fungorum." It includes nineteen hundred and thirty-seven species. These additions to the Sylloge bring up the number of species to the following, viz.: Pyrenomyceteæ, 7564; Sphæropsideæ, 4078; Melanconieæ, 606; Hyphomyceteæ, 3664; making a grand total of 15,912 species. ——A recent paper on Certain Cultures of Gymnosporangium, with notes on their Rœsteliæ, presented by Roland Thaxter to

the American Academy of Arts and Sciences, contains much of interest to the mycologist. As a result of these cultures the author of the paper concludes to connect the species of Gymnosporangium and Rœstelia as follows: *G. conicum*, with *R. cornuta; G. claviceps*, with *R. aurantiaca; G. clavariæforme*, with *R. lacerata; G. macropus*, with *R. pyrata; G. biseptatum*, with *R. botryapites; G. ellisii*, with *R. transformans*, probably. The Rœstelia of *G. globosum* is still left in doubt.——H. N. Patterson, of Oquawka, Ill., has brought out a handy check-list of North American Plants, including Mexican species which approach the United States boundary. It will prove very serviceable.——Cooke's "British Desmids" has reached the seventh number, and continues to maintain its high character. When completed it will form an excellent companion volume to Wolle's "Desmids of the United States."——Part III. of Macoun's "Catalogue of Canadian Plants" is devoted to the Apetalæ, including the Coniferæ. About one hundred pages are devoted to additions and corrections to Parts I. and II., while a very full index completes the volume. The publication is creditable to the Geological and Natural History Survey of Canada. It is to be hoped that the work will be continued.——The Eriogonous genus Lastarriæa Remy, has lately been studied by Dr. Parry, who confirms its generic rank. Three species are characterized, viz.: *L. chilensis* Remy of the Pacific Coast of North and South America; *L. stricta* Philippi, ined., from Chili; *L. linearis* Philippi, ined., Chili.——An interesting paper, by Thomas Meehan, on the Fertilization of *Cassia marilandica*, received some time ago, has been noticed before in these pages. The author found that not a single seed was produced when the flower was protected from the visits of insects.——Dr. Beal's "Lessons on Growing Forest Trees," in a late Bulletin of the Agricultural College of Michigan, possesses botanical as well as horticultural interest. ——Dr. Gray's Botanical Contributions (Proc. Am. Acad. Arts and Sciences, vol. xxi. pp. 363 to 413) includes besides a much needed revision of the North American Ranunculi, descriptions of plants from Northern Mexico, mainly from the collections made by C. C. Pringle and Dr. Edward Palmer. In referring to the need of a revision of the Ranunculi, the statement is made that "almost half a century ago the North American species of Ranunculus, as then known, were hastily compiled for Torrey and Gray's Flora, with very little knowledge of original materials; and they have not been elaborated since."——Numbers 146 and 147 of the *Journal of the Linnean Society* contain papers on the Mosses and Hepaticæ of Central Africa, by Wm. Mitten; Note on Balanophora, by Henry Trimen; a report on the Vegetation of Diego Garcia, by W. B. Hemsley, and the Forms of Seedlings, by Sir John Lubbock. The last will be noticed more fully in these pages hereafter.——The *Gardeners' Chronicle*

PLATE XIII.

1.



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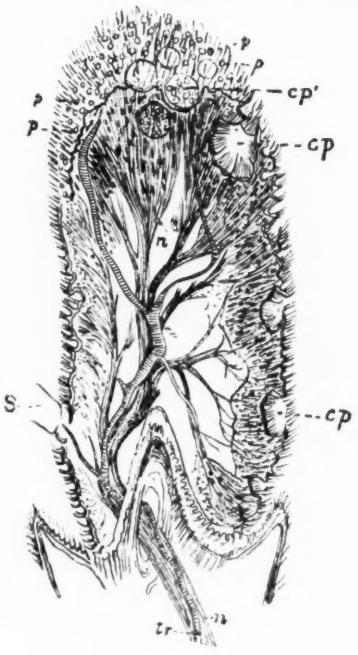

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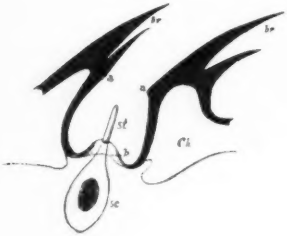

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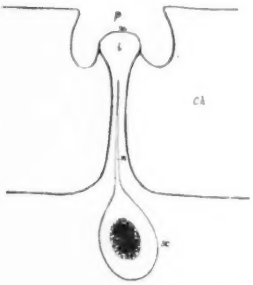

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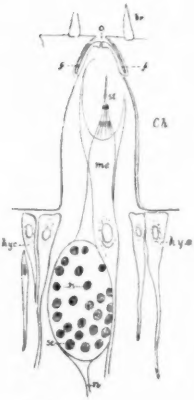


ORGANS OF SMELL IN INSECTS.

(London) has been reduced in price, now costing American subscribers about $4.60. The pages have been reduced slightly in size, and some changes have been made in the type and heading. This valuable journal (to botanists as well as to horticulturists) now enters upon its third series.

ENTOMOLOGY.

Hauser on the Organs of Smell in Insects.[1]—Although Hauser's researches have been published in Germany several years, they were so carefully made and conclusive that our readers will, we feel sure, be glad to have laid before them in detail the facts which prove so satisfactorily that the antennæ of most insects are olfactory rather than auditory in their functions. Kraepelin in 1883 confirmed Hauser's views, and recently Will has published an excellent paper on the organs of taste in insects, especially wasps, etc., so that our knowledge of the senses of Arthropoda has been greatly extended and cleared up within the last few years. It now appears that few insects are known to have genuine ears, those of the locusts and grasshoppers being alone proved to be auditory organs. It appears that most insects (the sound-producing ones excepted) are probably deaf, while nearly all have very acute senses of smell, taste, and touch.

That many insects possess an unusually acute sense of smell no naturalist disputes. A point in debate, however, is the site of the organ of smell in these animals. The author attempts to settle the question.

I. *Physiological Experiments.*—First of all one should observe as exactly as possible the normal animal in its relation to certain smelling substances, whose fumes possess no corrosive power or peculiarities interfering with respiration; then remove the antennæ and try after several days to ascertain what changes have taken place in the relation of the animal to the substance. In order to come to no false results it is often necessary to let the animals operated upon rest one or two days, for immediately after the operation they are generally so restless that a careful experiment is impossible.

The extirpation of the antennæ is borne by different insects in different ways; many bear it very easily, and can live for months after the operation, while others die in the course of a few days after the loss of these appendages. The animals seem to be least injured if the operation is performed at a time when they are hibernating. *Pyrrhocoris apterus* L., and many other insects, afforded a very striking proof of this relation.

Experiments made by placing the antennæ in liquid paraffine so as to cover them with a layer of paraffine, thus excluding the air, gave the same result as if the antennæ had been removed.

[1] Zeitschrift für Wissenschaft. Zoologie, xxxiv., 1880. Three plates.

The experiments may be divided, according to their object, into three groups. Experiments of the first kind were made on insects in their relation to strong-smelling substances, as turpentine, carbolic acid, etc., before and after extirpation of the antennæ. The second group embraces experiments on the relation of animals as regards their search for food; and finally the third group embraces experiments on the relation of the sexes relative to reproduction before and after the extirpation of the antennæ.

1. *Relation of insects to smelling substances before and after the loss of their antennæ.*—Taking a glass rod dipped in carbolic acid and holding it within 10 cm. of *Philonthus æneus*, found under stones at the end of February, it raised its head, turned it in different directions, and kept making lively movements with its antennæ. But scarcely had Hauser placed the rod close to it when it started back as if frightened, made a sudden turn, and rushed, extremely disturbed, in the opposite direction. When he removed the glass rod the creature busied itself for some time with its antennæ, while it drew them, with the aid of its fore limbs, through its mouth, although they had not come into direct contact with the carbolic acid. There was the same reaction against oil of turpentine, and it was still more violent against acetic acid.

After having many times carefully tested the relations of the normal animal to the substances mentioned, the antennæ were removed from the socket-cavity.

On the second day after Hauser experimented with the insects, they exhibited no reaction either against the carbolic acid, the oil of turpentine, or also against the acetic acid, although he held the glass rod which had been dipped into it for one or two minutes before and over the head. The creatures remained completely quiet and immovable, at the most slightly moving the palpi.

They showed otherwise no change in their mode of life and their demeanor; they ate with great eagerness flesh which had been placed before them, or dead insects, and some were as active as usual as late as May.

These beetles had, as proved by the experiments, lost the sense of smell alone; how far the sense of touch was lost Hauser could not experimentally decide.

The same results followed experiments with species of the genus Ptinus, Tenebrio, Ichneumon, Formica, Vespa, Tenthredo, Saturnia, Vanessa, and Smerinthus; also many species of Diptera and Orthoptera, besides Julus and Lithobius, while many larvæ reacted in the same manner.

Less satisfactory were the experiments with Carabus, Melolontha, and Silpha; there is no doubt that the species of these genera, through the extirpation of their antennæ, become more

or less injured as to the acuteness of their powers of smelling; but they never show themselves wholly unable to perceive strong-smelling substances.

The allurement of the substance acts for a longer time on those deprived of their antennæ, then they become restless, then they wander away from the glass tube held before them; still all their movements are but slightly energetic, and the entire reaction is indeterminate and enfeebled.

Experiments with the Hemiptera gave still more unfavorable results; after the loss of their antennæ they reacted to smells as eagerly as those did which were uninjured.

2. *Experiments on the use of the antennæ in seeking for food.*—Under this head experiments were made with Silpha, Sarcophaga, Calliphora, and Cynomyia.

Silpha and its larva were treated in the following manner: they were placed in large boxes whose bottoms were covered with moss, etc.; in a corner of the box was placed a bottle with a small opening, in which was placed strong-smelling meat. So long as the beetles were in possession of their antennæ they invariably after a while discovered the meat exposed in the bottle, while after the loss of their antennæ they did not come in contact with it.

In a similar way acted the species of Sarcophaga, Calliphora, and Cynomyia. Hauser, in experimenting with these, placed a dish with a large piece of decayed flesh on his writing-table. In a short time specimens of the flies referred to entered through the open window of the room. The oftener he drove them away from the meat would they swarm thickly upon it. Then closing the window and catching all the flies, he deprived them of their antennæ and again set them free. They flew about the room, but none settled upon the flesh nor tried to approach it. Where a fly had alighted on a curtain or other object, the decayed flesh was placed under it so that the full force of the effluvium should pass over it, but even then no fly would settle upon it.

3. *Experiments testing the influence of the antennæ of the males in seeking the females.*—For this purpose Hauser chose those kinds in which the male antennæ differ in secondary sexual characters from those of the female, and in which it is known that they readily couple in confinement, as *Saturnia pavonia*, *Ocneria dispar*, and *Melolontha vulgaris*. The two first-named insects did not couple after the extirpation of their antennæ. Of *Melolontha vulgaris* twenty pairs were placed in a moderately-sized box. On the next morning twelve pairs of them were found coupling. Hauser then, after removing the first lot, placed a new set of thirty pairs in the same box, cut off all the antennæ of the males and those of a number of females. On the following morning only four pairs were found coupling, and at the end of three days five others were observed sexually united.

From these experiments Hauser inferred that those insects deprived of their antennæ were placed in the most favorable situation, such as they would not find in freedom; for the space in which the insects moved about was so limited that the males and females must of necessity meet. But at the same time the results of the experiments cannot absolutely be regarded as proving that the males, after the loss of their antennæ, were then not in condition to find the females, because in the case of the above-mentioned moths, under similar conditions, after the extirpation of the antennæ no sexual union took place. If, however, the experiments made do not all lead to the results desired, Hauser thinks that the results agree with those of his histological researches, that in the greater number of insects the sense of smell has its seat in the antennæ. His results also agree with those of Perris.

II. Histological Researches on the Organs of Smell in Insects.—The organs of smell consist, in insects,—*i.e.*, all Orthoptera, Pseudoneuroptera, Diptera, and Hymenoptera, also in most Lepidoptera, Neuroptera, and Coleoptera,—

1. Of a thick nerve arising from the brain which is sent into the antennæ.

2. Of a sensitive apparatus at the end, which consists of staff-like cells, which are modified hypodermis cells, with which the fibres of the nerves connect.

3. Of a supporting and accessory apparatus, consisting of pits, or peg- or tooth-like projections filled with a serous fluid, and which may be regarded as invaginations and outgrowths of the epidermis.

Hauser adds a remark on the distribution of the pits and teeth in the larvæ of insects, saying that his observations are incomplete, but that it appears that in the larvæ the teeth are most generally distributed, and that they occur not on the antennæ alone, but on the palpi; but in very many larvæ neither pits nor teeth[1] occurred. In the Myriopoda teeth-like projections occur on the ends of the antennæ. In Lithobius they form very small, almost cylindrical, pale organs.

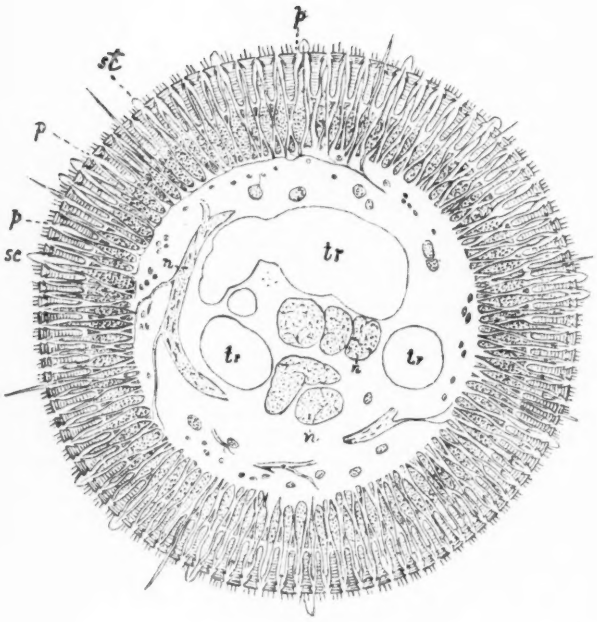
In the course of a special description of these sense-organs in the Orthoptera, Hauser describes at length those of *Œdipoda cærulescens* and *Caloptenus italicus*. On one antennal joint of Caloptenus was often counted fifty pits; on the anterior joints the number diminishes to about thirty. Hauser thinks that in all Orthoptera whose antennæ are like those of Caloptenus occur similar pits, as he found them in Stenobothrus as well as Œdipoda. Gryllotalpa possess similar pits,—four to six on each antennal joint, making between three and four hundred pits on each antenna.[2] In *Mantis religiosa* the pits were not detected,

[1] Hauser here uses the word *taster*, but this means palpus or feeler. It is probably a *lapsus pennæ* for teeth (*Kegel*).

[2] In 1870 I observed these sense-pits in the antennæ, and also the antenna-like anal

PLATE XIV.

6.



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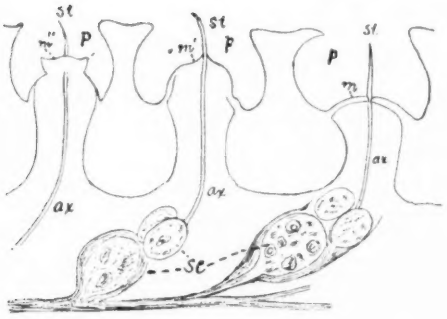


ORGANS OF SMELL IN INSECTS.

but on each joint, except the eight basal, there are about two hundred small, hollow-curved teeth with a fine opening in front.

In the Neuroptera (Chrysopa) there occur on the antennæ, besides numerous very long tactile bristles, small pale, transparent teeth. No pits could be detected.

In the Hemiptera (two species of Pyrrhocoris only were examined) only two kinds of tactile bristles occurred, but Hauser detected no pits, though Lespés states that they are present.

Of the Diptera, Hauser examined more than sixty species. The pits in the *Diptera brachycera* (Muscidæ, etc.) are unexceptionally confined to the third antennal joint. Their number varies extraordinarily in the different species. *Helophilus florens* has on each antennal disk only a single pit, while *Echinomyia grossa* possesses two hundred of them. In flies of certain families the pits are compound and contain ten, twenty, and often one hundred olfactory hairs, partly arising from the coalescence of several pits. Such pits are usually divided by lateral walls into several chambers, whose connection is only indicated by their common outlet. Simple olfactory pits with a single olfactory style were observed only in the Tabanidæ, Asilidæ, Bombylidæ, Leptidæ, Dolichopidæ, Stratiomydæ, and Tipulidæ. In the last the compound forms do not occur at all, but in the other families mentioned also occur compound pits, receiving from two to ten nerve-terminations.

The antennal pits of flies are always sac-like invaginations of the external chitinous integument, of manifold shapes, opening externally and never closed by a membrane. The pits differ but slightly in the different species, and that of *Cyrtoneura stabulans* (Fig. 2) is described at length as typical of those of brachycerous flies in general.

The olfactory pits of the Tipulidæ seem to have a somewhat different structure, since the external passage is closed. It is circular, surrounded with a slight chitinous wall and not covered with bristles. Such pits in their external appearance are like those of the locust (Caloptenus) and many Hymenoptera. They are situated usually on the third antennal joint. *Pachyrhina pratensis* L. has about sixty of them, as have *Tipula oleracea* L. and Ctenophora.

In the Lepidoptera, olfactory pits are much like those of flies. Hauser describes in detail those of *Vanessa io.* Those of the moths were not examined, but they can be readily and satisfactorily proved to be the site of the olfactory sense.

appendages (cercipoda) of the cockroach (*Periplaneta americana*). I counted about ninety pits on each stylet. They are much larger and much more numerous than similar pits in the antennæ of the same insect. I compared them to similar pits in the antennæ of the carrion-beetles, and argued that they were organs rather of smelling than hearing. (AMER. NAT., iv., Dec. 1870.) Organs of smell in the flies (Chrysopila) and in the palpi, both labial and maxillary, of Perla were described in the same journal.—*A. S. P.*

Historical researches in the Coleoptera generally gave a very unfavorable result, contrary to Lespés's views. That author states that in the Carabidæ the pits are found on the four first joints, but Hauser could discover them in none which he examined. Usually only tactile bristles occur, so also in the Cerambycidæ, Curculionidæ, Chrysomelidæ, and Cantharidæ.

Olfactory pits, however, without doubt occur in Silpha, Necrophorus, Staphylinus, Philonthus, and Tenebrio. The openings of the pits are small and surrounded with a small chitinous ring; in Silpha, Necrophorus, and Tenebrio they cannot easily be distinguished from the insertion-cavities of the bristles, but in Philonthus and Staphylinus they are less like them, being distinguished by their somewhat larger size and their often more oval form. In *Philonthus æneus* about one hundred such small pits occur irregularly on the terminal joints; besides, in this species on each side of the terminal joint is an apparatus, which is like the compound pit generally occurring in the Diptera.

Very remarkable pits occur in the antennal lamellæ of *Melolontha vulgaris* and other Lamellicorns. Only on the outer surface of the first and seventh (in the female the sixth) antennal leaf, as also on the edges of the other leaves, arise scattered bristles; on the inner surface of the first and seventh leaves, as also on both surfaces of the second to sixth leaves, are close rows of rather shallow depressions of irregular form, some circular, others regularly hexagonal. Their number is enormous: in the males thirty-nine thousand, in the females about thirty-five thousand, occur on each antenna.

The antennal pits and teeth of *Dytiscus marginalis* are morphologically and physiologically identical with those of bees and wasps. In *Anopthalmus bilimekii* St., Hauser found on the last antennal joints about sixty teeth, which essentially differ in form from those previously described; they are very pale, transparent, cylindrical, elongated, and bent elbow-shaped on the first third, so that the last two-thirds run parallel with the antenna. (Fig. 12.) The length of these remarkable teeth is 0.035 mm., their breadth 0.005 mm. I only found them in Anopthalmus, and in no other species of Carabidæ; they must resemble the teeth described in Chrysopa. Similar teeth occur on the maxillary and labial palpi of beetles. *Dytiscus marginalis* possesses at the end of each terminal palpal joint a group of very small teeth, which were also detected in *Anopthalmus bilimekii*, *Melolontha vulgaris*, etc. In *Carabus violascens* were detected on the maxillary palpi large, plainly microscopical, white disks which are surrounded with a great number of extremely small teeth.

Whether the above-described organs on the palpi of beetles should be considered as olfactory or gustatory in their nature

can only be determined by means of physiological experiments; they probably receive taste-nerve terminations.

The Hymenoptera furnished very good material for histological purposes, so that Hauser could not only study the terminal apparatus of the olfactory nerves in the perfect insect, but also in three different stages of the pupa. These are described at length, as regards the distribution of the pits and teeth, in *Vespa crabro;* each joint of the antenna (flagellum) possesses between thirteen hundred and fourteen hundred pits, nearly sixty teeth, and about seventy tactile hairs; on the terminal joint there are more than two hundred teeth, so that each antenna has between thirteen thousand and fourteen thousand olfactory pits and about seven hundred teeth (Kegel). Fig. 6 represents a cross-section through the penultimate antennal joint of *Vespa crabro;* we can see how thick are the series of openings on the surface of the antennæ, and how regular is the distribution of the teeth.

The distribution of the olfactory pits and olfactory teeth is thus seen to be very general; the deviations are so insignificant that there is no reason for the establishment of more than one type.

Antennal pits with a small crevice-like opening occur in genera nearly allied to Vespa and also in most Ichneumonidæ, Braconidæ, and Cynipidæ. But the crevice-like openings in these families are considerably longer and often are of a somewhat twisted shape. In all the species with translucent antennæ we can recognize the inner mouth of the pit as a round or nearly round disk situated usually under the middle of the opening. The antennal pits of *Apis mellifica*, as well as those of Bombus and allied genera, differ from those of the Ichneumonidæ in being not like crevices, but circular openings.

The distribution of the olfactory peg or tooth-like projections (Kegel) seems to be much more limited than that of the pits in the Ichneumonidæ. Hauser could not find any. *Apis mellifica* possesses on each antennal joint only about twenty slender pale teeth, scarcely a third as many as in *Vespa crabro;* on the other hand Formica, of which genus several species were examined, seems to have far more teeth than pits; they are relatively long, pale, transparent and somewhat clavate; they are not unlike those of Chrysopa; on the terminal joint only were these round openings, which led into a bottle-shaped invagination of the integument and contained an olfactory style. In the Tenthredinidæ only teeth and no pits were to be detected. Sirex has on the under side of the nine last joints of each antenna a group of from two hundred to three hundred small teeth, which resemble those of *Vespa crabro;* Lyda has on the terminal joints about one hundred teeth.

The author then discusses these facts from the Darwinian

point of view. His views we may present in a subsequent number of this magazine.—*A. S. Packard.*

EXPLANATION OF THE FIGURES.

LETTERING.—*a*, *a*, circular thickening of the skin surrounding the opening of the olfactory pit; *ax*, thread-like continuation of the nerve-cell; *b*, vesicle-like bottom of the olfactory pit, through which the olfactory style passes; *br*, bristle in Fig. 3, stout, and protecting the olfactory pit; *bs*, bent bristle or seta; *ch*, chitinous integument of the antennæ; *d*, seen in section; *f*, invaginated pit; *fv*, Forel's flask-shaped organ; *fvo*, its opening seen from the surface; *gl*, gland-like mass of cells; *hyc*, hypodermic cells; *i*, entrance into the canal belonging to the pit; *m*, olfactory membrane; *m'*, *m''*, *mc*, membrane-forming cell; *n*, nerve of special sense; *nc*, nucleus of the sense- or ganglion-cell; *o*, opening into the olfactory pit; *p*, olfactory pit; *cp*, compound pits; *pw*, wall of the pit; *s*, a large seta; *sc*, sense- or ganglion-cell; *st*, olfactory or sense-style, sometimes peg-shaped; *tb*, tactile bristle.

FIG. 1. Olfactory organ of Caloptenus.

FIG. 2. Longitudinal section through the third antennal joint of a fly (*Cyrtoneura stabulans*), showing the compound pits from above and in section.

FIG. 3. Vertical section through a single olfactory pit in the antenna of the horse-fly (*Tabanus bovinus*).

FIG. 4. Antennal pit of *Melolontha vulgaris*, seen in vertical section.

FIG. 5. Section through an olfactory pit of *Vespa crabro*.

FIG. 6. Section through antennal joint of *Vespa crabro*, showing the great number of olfactory pits, the olfactory and tactile bristles.

FIG. 7. Olfactory pits of the antenna of *Melolontha vulgaris*.

FIG. 8. Olfactory pits of the antenna of Stenobothrus.

FIG. 9. Olfactory pits of the antenna of *Vespa vulgaris*.

FIG. 10. Olfactory pits of the antenna of Formica.

FIG. 11. Olfactory pits of the antenna of Bombus. FIGS. 7–11, after Kraepelin.

FIG. 12. Organ of smell of Anophthalmus. After Hauser.

ZOOLOGY.

Notes on the Larger Florida Planorbes.—Having occasion lately to examine a number of Planorbes from Florida, I noticed that considerable confusion exists in the names various collectors give the species. I give below notes on all the species I have received from the State.

Planorbis trivolvis Say.

P. bicarinatus Say. Northern Florida. Stearns has recorded this species from several Pacific coast localities. I found it abundant and typical in Southern Texas. It has, thus, a range nearly as extensive as the *P. trivolvis*.

P. tumidus Pfr. is not an uncommon species in the peninsula, though hitherto overlooked, probably confused with *glabratus* or *trivolvis*. This shell is quite distinct from all other Florida species. Several rather immature specimens, apparently the same, have been sent me from Wacama Lake, N. C.

P. glabratus Say. *P. duryi*, var. *intercalaris*, approaches this species in some characters. From the other known Planorbes, *glabratus* is quite distinct. Distribution probably the same as *P. tumidus*, but decidedly local, according to the information given by my correspondents.

P. duryi Wetherby is a form widely spread and apparently

abundant in the peninsula, but usually *not* rightly named in cabinets. It varies greatly in form from typical *duryi*, which is four-whorled, carinated above to the aperture, and has only a fraction over one whorl visible on base, to a flatter, more discoidal form which I have called var. *intercalaris*, showing over three whorls of base, and with the outer whorl rounded above, much as in *glabratus* Say. Other specimens have the whorl ascending at aperture, and, as Say would put it, "labrum horizontally subrectilinear." This form is usually marked "*lentus* Say" in collections, sometimes "*corpulentus* Say," but the solidity, polished surface, etc., at once separate *duryi* in all its varieties from these shells and from *trivolvis* Say. Somewhat malleated specimens are also found, and the uptilting of inner whorls mentioned in Wetherby's description is a not uncommon variation in the typical form. This species is allied on one hand to *glabratus* Say, and in other characters approaches

P. scalaris Jay,—a snail which is placed in a different genus by nearly every author who mentions it. After figuring in Paludina, in Physa, and in the exotic genus Ameria, it may finally be located in the Helisoma[1] section of Planorbis, wtth all the foregoing species. Although the resemblance of *P. scalaris* to the *young* of normal Planorbis is quite marked, it is probably not in any true sense a case of persistence of embryonic characters. Its derivation from some such discoidal species as the *P. duryi* is more likely.—*Harry A. Pilsbry.*

Is Littorina litorea Introduced or Indigenous?—In regard to the question as to whether *Littorina litorea* is introduced or indigenous, Dr. Dawson has informed the writer of the article on this subject in the AMERICAN NATURALIST for November, that he collected the shell at Pictou, N.S., as far back as 1840, and probably earlier. Dr. Dawson says, further, that *L. litorea* "is and has long been widely distributed in Northumberland Strait and its vicinity, and that specimens authenticating this may be found in my collections in the Peter Redpath Museum of McGill University." Dr. Dawson believes, from its wide distribution so far back, that "it is a regular and probably aboriginal member of the fauna of Acadia."

It is with great diffidence that the writer ventures to disagree with so thorough a student of these matters as Dr. Dawson. But he is unable to see that anything is proven by this new addition to our knowledge of the distribution of the shell, except that it existed upon our shores earlier and more widely spread than

[1] Helisoma naturally includes not only such species as *bicarinatus* Say and *lordi* Bd., but all the large American species which have the inner whorls of spire sharply carinated above, whether the aperture be rounded or angular in the adult. All the species placed in the typical section of Planorbis in Land and Fresh-Water Shells, Pt. II., except *havanensis* and *liebmanni*, which I have elsewhere shown to belong in Segmentina, and Subcrenatus Cpr., belong in the section Helisoma.

we supposed. We cannot perceive that it affects the evidence tending to show that it has been introduced.—*W. F. Ganong.*

Development of Alpheus.—Mr. F. H. Herrick contributes to No. 54 of the Circulars of Johns Hopkins University an account of his researches on the development of several species of the shrimp Alpheus. There is a small cup-shaped gastrula, and the early rudiments of the embryo have a V-shaped outline, the base of the V being formed by the rudimentary abdomen. The three nauplius appendages appear nearly simultaneously, and the upper lip grows out between the first and second antennæ. The later history of the eyes is traced, but the optic invagination described by Reichenbach in Astacus and Kingsley in Crangon was not noticed.

Deep-Sea Isopoda.—In the *Transactions of the Zoological Society* (vol. xii. pp. 77–141, pls. 16–27, 1886) the Rev. A. M. Norman and the Rev. T. R. R. Stibbing enumerate and describe the deep-sea Isopoda of the families Apseudidæ, Tanaidæ, and Anthuridæ, which have been taken by the recent English dredging expeditions in the "Lightning," "Valorous," and "Porcupine." In all, twenty-six species are enumerated, of which seventeen are new. Several new genera are characterized: Sphyrapus, Tanælla, Alaotanais, Cyathura, Anthelura, Hyssura, and Calathura. Several changes are introduced in the names of the North American forms. *Leptochelia algicola* Harger is regarded as synonymous with *L. savignyi* Kroyer and *L. dubia* Kr. *Anthura brunnea* Harger and *A. polita* Stm. are referred to *Cyathura carinata* (Kr.). *Anthura brachiata* Stm. is made the type of the new genus Calathura. Under the general account of the family Tanaidæ are some very interesting remarks on the existence of two forms of males in this group.

Molluscs of Lake Tanganyka.—Pelseneer gives a list of twenty-five species of terrestrial and fluviatile molluscs brought back from the neighborhood of Lake Tanganyka by Captain Stormes. Among the most interesting points made out are the anatomy of the genus Pliodon, which throws light on the relationship of this mollusc, the affinities of which were uncertain before. He finds that it is distinguished from the Unionidæ by two posterior orifices, a rather long pallial sinus separating the branchial and pedal orifices; the mantle cavity is completely divided into anal and branchial chambers by the branchiæ; and by the shapes of the labial palpi. The affinities are rather with Mutela, Spatha, Triquetra, and other members of the family Mutelidæ of H. and A. Adams. The terrestrial molluscan fauna of the region is not specially interesting, but that of the fresh-waters has been characterized as "marine" in its facies. This aspect Pelseneer does not recognize.

Echinoderm Morphology.—Ph. H. Carpenter, the able English student of the living Crinoids, has recently published two papers on the morphology of the Crinoids, in review of the account of *Antedon rosacea* given by Vogt and Yung in their "Traité d'Anatomie Comparée Pratique." In one (*Annals and Magazine Natural History*, January, 1887) he reviews almost every point made by the authors, and points out many sins of omission and commission. The second paper is in the *Quarterly Journal of Microscopical Science* for the same month, and deals with what Vogt and Yung regard as symbiotic algæ, but which have been previously called sacculi. He shows by their structure, relationship to different species of Comatula, their development, and other points, that they cannot be algæ, and thinks that their nature is still as obscure as it was before the publication of the "Traité Pratique" was published.

Nettle-Cells.—R. von Lendenfeld has a paper on the function of the nettle-cells of Cœlenterata in the January number of the *Quarterly Journal of Microscopical Science.* Nettle-cells are defensive structures situated in the ectoderm, and usually also in the endoderm, of all Polypomedusæ. Their structure is some-

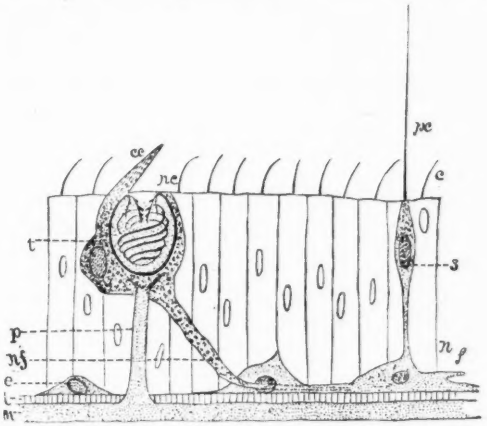


Diagram of a nettle-cell with the surrounding nucleated columnar epithelium: *c*, cilia; *ce*, cnidocil; *e*, sub-epithelial muscle-cell; *f*, tangential nerve-fibre; *l*, longitudinal striated muscles; *m*, mesodermal supporting lamella; *n*, ganglion-cell; *nf*, nerve connecting ganglion-cell with *ne*, nettle-cell; *p*, peduncle of Hamann; *pc*, palpocil connected with *s*, sense-cell; *t*, thread coiled up inside of nettle-cell.—After Lendenfield.

what complicated. They consist each of a single cell hollowed within to contain a long spirally coiled thread, and produced at the surface into a strong process,—the cnidocil,—which

projects in the direction from which foreign objects are most likely to reach the organism. Under proper stimulus the nettle-cell contracts, forcing out the contained thread, which becomes turned inside out during the operation, as one may invert the finger of a glove. It is this thread—or rather multitudes of them, each charged with poison—which produces the well-known nettling effects of many jelly-fishes. The thread is forced out with great force, and penetrates soft bodies, bearing the poison with it. The question is, What is the physiology of the contraction? Lendenfeld reviews the previously existing ideas and shows their weak points. His own view is that the action of these structures is to some extent voluntary and under control of the ganglion-cells. The contraction of the peduncle of Hamann withdraws the nettle-cell below the surface under certain circumstances. Contraction of the nettle-cell itself and the forcing out of the thread is reflex; the cnidocil is the sensory organ, and on the application of stimulus to this the act takes place. The granular peduncle first described by Lendenfeld is regarded as the nerve-fibre connecting the nettle-cell with the nervous system of the animal. Von Lendenfeld's figure, reproduced here, will elucidate the structures concerned.

Some Rare Indiana Birds.—The present winter in Indiana has been remarkable for the occurrence in this State of several species of birds which are not often seen here. The rarest of these is perhaps the Evening Grosbeak (*Hesperiphona vespertina*). On Saturday, January 22, Mr. Charles H. Bollman saw and shot a single specimen of this rare bird on the campus of the State University at Bloomington. On the same day, Mr. Cal. Meridith and a companion, at Frankfort, one hundred and twenty-five miles north of Bloomington, saw a flock of twelve, from which they secured five. I learn that one or more specimens were seen about the same time in Lake County by members of the Ridgway Ornithological Club, who were enjoying a sleigh-ride in that part of Indiana. A few days later two other specimens were seen in the vicinity of Frankfort. This is, I believe, the first record of the occurrence of the Evening Grosbeak in Indiana.

From all parts of the State come reports of captures of Snowy Owls. I hear of three at Lebanon, three at Valparaiso, six at Indianapolis, one at Greencastle, two at Martinsville, one at Sullivan, and two each at Columbus and Greensburg. These no doubt represent not more than one-half of the number actually taken in the State. They were most abundant in November, and none have been reported since the 1st of January. Short-eared Owls have also been reported much more common than usual, and Bald and Golden Eagles have been taken with unwonted frequency.

In this connection it is proper to record the occurrence of the

Florida Snake-Bird (*Plotus anhinga*) in this State. According to Mr. Fletcher M. Noe, of Indianapolis, a fine male, in full plumage, was taken on the West Fork of White River, two miles south of Indianapolis, on August 25, 1886. A month later Mr. Noe received a specimen of the Western Grebe (*Æchmorphus occidentalis*), which was killed near the same place.—*B. W. Evermann, Indiana State Normal School*, February 14, 1887.

Zoological News.—BIRDS.—At the recent Scientific Congress at Paris, M. de Montessus read a memoir upon the present state of ornithological science in Paris. Among other facts he mentioned the capture of *Synoicus lodoisiæ*, an Australian gallinaceous bird, in the Department of Sâone-et-Loire. Previously a specimen had been killed in Lombardy, and these are the only specimens known to have been taken in Europe, but are sufficent to cause the enumeration of the species among the casual visitors to that country.

WORMS.—Mr. James E. Benedict describes one new genus and five new species of tubicolous Annelids in the "Proceedings U. S. Nat. Museum for 1886." All of them are from the warmer waters of America, and were collected by the Fish Commission steamer "Albatross."

MOLLUSCA.—Paul Pelseneer, in the "Bulletin Sci. Dépt. Nord," II., vol. ix. (reprinted in the *Annals and Magazine of Natural History* for January, 1887), gives a review of the Gymnosomatous Pteropods. He recognizes only six genera, arranged in four families among the previously described species, but describes a new genus and species, *Notobranchæa mcdonaldi*, from off the coast of the Carolinas. Only a single specimen is known, which is in the United States National Museum. The foot-notes appended to the reprint of the article add considerably to the value of the paper.

ECHINODERMS.—Rev. J. G. Swan calls attention, in the *Bulletin of the United States Fish Commission*, to the abundance of Holothurians in the region of Queen Charlotte Islands and in Alaska, and suggests that it may prove profitable to collect and cure them into trepang for the Chinese market. In China they command a price of about forty or fifty dollars a ton, and their preparation is not very difficult.

SPONGES.—At a recent meeting of the Zoological Society of London, Dr. R. von Lendenfeld read a paper on the classification of sponges and their systematic position. His extensive investigations in the rich sponge fauna of Australia, as well as on the collections of the "Challenger" expedition, have given him facilities rarely excelled. He proposed an arrangement in which

forty-six families were described and the principal genera enumerated. His paper also contained a tolerably complete bibliography of the subject, the size of which is shown by the fact that it embraced the titles of fourteen hundred and forty-six papers. The systematic position of the sponges was also discussed.

EMBRYOLOGY.[1]

Haddon's Introduction to the Study of Embryology.[2]— This new work, now in press, is apparently designed to give the student a comprehensive outline of the science of embryology in a moderate compass, with such illustrations as will enable him to appreciate the fundamental similarity of many of the stages of the embryos of the different classes and orders of the Metazoa as represented by specific forms. A manual of this sort has been very much needed for the class-room. The monumental treatise of Balfour, in two volumes, already needs revision, so fruitful have been the labors of active embryological workers within the last five years, or since its completion. That activity itself has been very largely due to the stimulus given to ontogenetic research by that singularly endowed genius, lost to us before he had had time to develop the germs of the great generalizations and suggestions which are so lavishly strewn through the pages of his great work. Balfour's large work, also, is not adapted to the purpose of a class-room manual, and can only be used as a book of reference or as a guide to the advanced student. In the first volume, and the early part of the second, the groups are treated of separately and not directly and comparatively, so that it is not well adapted to serve as a text-book for the laboratory in elementary work. Other elementary text-books use only extremely modified forms, such as the chick and the mammal, as types; other lower groups being scarcely alluded to. This tends to develop a bias in the mind of the student which it is hard for him to shake off, and in extending the range of his studies he finds himself almost unwittingly trying to attempt to apply his knowledge of the development of the higher forms to that of the lower, with the result that he becomes confused in making his comparisons. To overcome this difficulty we need an elementary work which will contrast the higher and lower types at once, and in such a way as will lead the student to at once see the agreements and differences in the methods of development of different types. It is especially important to show what a profound influence the presence of a larger and larger amount of yelk has had in modifying gastrulation; how the types of cleavage have been apparently modified from the same cause,

[1] Edited by Dr. JOHN A. RYDER, Philadelphia.

[2] An Introduction to the Study of Embryology, by Alfred C. Haddon, M.A., Professor in the Royal College of Science, Dublin. London, 1887.

and so on. These and kindred questions will evidently be fairly dealt with in Professor Haddon's treatise, judging from the advanced sheets of the first forty pages of the work, which the editor of this department has had the opportunity of examining. The work will evidently be up to date, and many points upon which the earlier authors were uncertain will be cleared up. The newer views as to the origin of the middle germinal layer will be presented, and Duval's discoveries in the development of the chick will receive the attention they deserve. The more recent discoveries in mammalian embryology and the discussion of karyokinesis, so far as it relates to embryology, will also find a place. On the whole, it may be said that this work is a timely one, which will be welcomed by all who are alive to the significance of the great issues of the embryological science of the future. The author and publisher are also to be congratulated upon the many new figures introduced,—many of them original,—and the excellent typographical appearance of the pages. The style of the author is clear and terse, a matter that is not always as well attended to by the authors of elementary text-books as is desirable, in spite of the remarkable precedents before them in the clearly-written elementary manuals by such writers as Huxley, Clifford, and Tyndall.

Development of Mysis.—Nusbaum gives (*Biol. Centralblatt*, vi. 663) a preliminary account of his observations on the development of Mysis. According to him the egg is surrounded by a blastema, and has the nucleus lying at the formative pole. The result of the first segmentation is to form two cells, one of which forms the blastoderm while the other sinks into the yelk. The larger central cells of the blastoderm later divide and give rise to cells which sink beneath the blastoderm, and together with the product of the first segmentation just mentioned are called "Vitellophags." After this process the rudiments of the embryo appear,—a caudal area from which extend forward the ventral bands, which diverge like a V and terminate in the oval cephalic lobes. Now, according to Nusbaum, a shallow invagination takes place in the caudal area, and the invaginated cells undergoing a rapid proliferation form a solid entoderm. Behind this point the abdomen now grows out. The mesoderm, says Nusbaum, arises as two bands from the ventral bands. The vitellophags at first lie just beneath the germinal area, but later they sink deeper into the yelk, and as their name implies they feed upon the yelk. Nusbaum has some comparisons with the development of various hexapods, which he thinks are similar in the formation of the germinal layers, and his vitellophags he compares to similar cells in Scorpio and Oniscus, as well as to the phagocytes of Metschnikoff. He also describes a dorsal organ which appears at first as a paired ectodermal thickening, the

halves of which eventually unite on the dorsal median line. Of its function or meaning he expresses no opinion, but thinks it is the same as the dorsal organ well known in Tetradecapods.

While we must wait for the publication of the final paper—promised in the *Archives de Zool. Experimentale*—before expressing definite conclusions as to the accuracy of Mr. Nusbaum's interpretations, it would appear as though he had fallen into several errors. First, his vitellophags are apparently ento-mesoderm, and their formation is the gastrulation. Second, the gastrulation described by Nusbaum can be reconciled with the formation of the ventral flexure, and his mesoderm, as shown by his figure, is clearly the early stage of the nervous system. Looked upon in this way, Nusbaum's account is reconcilable with what is known of the development of other Crustacea; in any other way it is unintelligible. Nusbaum, it may be said in passing, is not the first one who has mistaken the ventral flexure for an invagination. —*J. S. K.*

Development of Spiders.—Morin gives (*Biol. Centralblatt*, vi. 658) an account of the development of Theridion, together with notes on that of Pholcus, Drassus, and Lycosa. The nucleus lies at the centre of the egg, and not until the third segmentation (eight cells) does the yelk segment. From this point the segmentation of the yelk pyramids accompanies that of the nucleus, through the stages of 16, 32, 64, etc., until the 128-cell stage is reached. Morin saw no polynuclear pyramids. At the 128-cell stage the nuclei and the surrounding protoplasm have reached the surface and form the blastoderm. They then separate from the pyramids, and the yelk then forms a homogeneous unnucleated mass. The blastoderm now becomes thicker on the ventral surface, and from its centre cells are budded inwards, some of which remain between the parent cells and the yelk, while others sink into the yelk itself. The germ now consists of all three layers. Morin does not regard the primitive cumulus as of such importance in the formation of the germ layers. In his experience it does not appear until after they are formed; indeed, he could not find it in any stage in Theridion. In Pholcus it was formed chiefly of mesoderm-cells, the ultimate fate of which was to form blood-corpuscles. In other points of the early development he agrees well with Locy (see this journal, xx. p. 676). The germinal area now becomes divided into segments, and then the appendages appear, first the four pairs of walking-legs, next the maxillæ, and then the mandibles; the abdomen has but four pairs of rudimentary appendages. At the same time the appendages appear the body cavity begins to form. The heart is formed much as in annelids, and as described by Kowalevsky and Schulgin in the scorpion. Its cavity is a remnant of the segmentation cavity. Now the splanchnopleure

becomes thrown into a series of folds (Balfour's septæ) in the abdominal region, dividing the yelk into a series of lobes, the rudiments of the liver.[1] The proctodæum and stomodæum offer nothing for note. The mesenteron does not begin to take definite shape until a day or two before hatching. Then the entoderm-cells which are scattered through the yelk gather at the inner ends of the fore and hind guts, and later unite in the middle. A similar process gives rise to the liver epithelium. This process is not completed at hatching, and for some time the young spider takes no food, the yelk remaining serving for food. The lungs arise as ectodermal invaginations at the base of the first pair of abdominal appendages, these becoming converted into their outer covering. The second pair of abdominal appendages disappear, the third and fourth are converted into the spinnerets, the spinning glands arising as ectodermal invaginations into their walls. —*J. S. K.*

PSYCHOLOGY.

The Seat of Consciousness.—M. Steiner, of Heidelberg, presented to the Academy of Science of Berlin, on January 7, 1887, a memoir on the consciousness of the cerebral hemispheres in fishes. The author, who has published a similar paper on the Batrachia, comes to the following conclusions:

1. In the fishes voluntary movements and the ability to feed spontaneously (proving the existence of both reflex and direct sensations) *persist* after the removal of the hemispheres.

2. In Batrachia these functions are bound to the hemispheres, excepting vision, which remains after their removal.

3. In birds vision is also located in the hemispheres, but not cutaneous sensation.

4. In the Mammalia, finally, the cutaneous sensations also are located in the hemispheres.

The author therefore concludes that in the Vertebrata the functions of the middle brain emigrate little by little into the hemispheres as they develop; or, rather, that the evolution of hemispheres depends on a successive accumulation of functions which at first belong to the middle brain.—*A. Herzen in Revue Scientifique*, No. 9, 1887.

Remarkable Intelligence of a Rat.—As throwing light upon the question of the intelligence of the animal creation, in the exhibition of memory and reasoning power, beyond the mere pale of recognized instinct, I wish to give the readers of the AMERICAN NATURALIST a brief account of an interesting incident of which I was witness. On a very warm day in early summer I happened to be standing near a chicken-coop in a back yard when I noticed the head of a very gray and grizzled rat thrust

[1] Compare Limulus.—*Ed. Nat.*

from a neighboring rat-hole, and concluded to watch the movements of the veteran. After a careful survey of the surroundings, our old rodent seemed to be satisfied that all was right and made a cautious exit from the home retreat. A fresh pan of water had been recently placed before the chicken-coop for the use of Mother "Chick" and her interesting brood. These all seemed to have satisfied their thirst, and the water looked a friendly invitation to the thirsty old rat, which immediately started towards it. The rat had not reached the pan before five half-grown young ones rushed ahead and tried to be first at the water. The old rat thereupon immediately made a leap like a kangaroo, and was at the edge of the dish in advance of the foremost of her litter. Then ensued a most remarkable occurrence. The mother rat raised herself on her haunches and bit and scratched her offspring so severely, whenever they attempted to reach the water, that they all finally scudded away, evidently very much astonished and frightened at the strange and unaccountable behavior of their mother. I was as much astonished as they, and awaited with renewed interest the outcome of this remarkable performance. When the little ones were at a safe distance, the reason for her extraordinary behavior began to be revealed at once in the intelligent actions of the old mother rat. She first wet her whiskers in the water, looked suspiciously about her, then very cautiously and carefully took a dainty little sip of the liquid. She tasted it as tentatively and critically as a professional tea-taster, and when she was satisfied that it contained no poisonous or other deleterious matter, she gave a couple of squeaks, which quickly brought her young and thirsty brood to her side, and all fearlessly drank to their fill. Now, this old mother rat was experienced, had evidently learned her lesson in that school thoroughly, and so she would not allow her young and untaught litter to taste water which might have contained *rat poison*, or what not, until she had satisfied herself that the liquid was harmless. As I witnessed this little scene in lowly animal life the thought would keep coming, Does not this look very like reason?—*J. Croll Baum*, 630 *N. Broad St., Phila., Pa.*

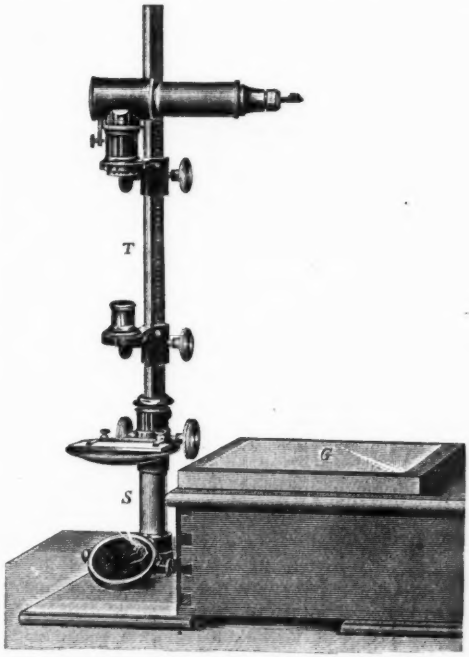
Ants and Sunflowers.—While riding out, one day in July last, over the prairies north of Kirwin, Phillips County, Kansas, my attention was attracted by a number of ant-hills surrounded by sunflowers. A closer examination showed that the hills were inhabited by a large red ant, one-half to three-quarters of an inch long. Their hills were only two or three inches high and from one to two feet in diameter, but for a radius of two to four feet around each hill every particle of vegetation was cleared off, and around the outside of this cleared space grew a single row of sunflowers, affording considerable shade to the circular court within.

The prairie was unbroken where these hills were seen, though cultivated fields were not far distant. Query, Where did the ants get their sunflower seed?

There were three other gentlemen with me who observed and commented on this curious circumstance.—*Erving L. Richardson.*

MICROSCOPY.[1]

The Embryoscope.—The embryoscope devised by Hartnack[2] represents an improved form of the drawing apparatus introduced by Professor His.[3] The magnifying power of this instrument may be made to vary at pleasure from *four to seventy* diameters, thus offering the same facilities for making exact contour drawings with low powers that the microscope affords with higher powers.



For this wide range of magnification only two objectives are used. The height of the rod bearing the mirror, the object-table, the objective, and the camera lucida, is about 40 cm. The glass

[1] Edited by C. O. WHITMAN, Ph.D., Milwaukee, Wisconsin.
[2] Zeitschrift für Instrumentenkunde, Sept. 1881, p. 284.
[3] Anatomie menschlicher Embryonen, Leipzig, 1880, p. 8.

plate, *G*, resting on the étui, serves as a drawing surface. All parts of the apraratus can be packed in an étui measuring 38 cm. × 22.5 cm. × 9.5 cm.

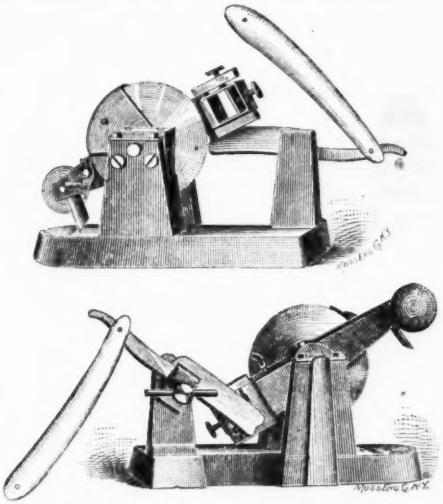
The magnifying power varies according to the relative positions given to the object-table, objective, and camera. The determination of these positions for different magnifications should be made before using the instrument. For this purpose a millimetre scale may be placed on the object-table, and the camera and objective moved until the picture projected on the drawing surface has the desired enlargement. The following table, showing the positions for given magnifications, was prepared by His. The numbers will vary somewhat for different eyes, hence the necessity of preparing one's own table.

	Magnification.	Upper edge of Object-carrier. mm.	Upper edge of Camera-carrier. mm.	Diameter of field of vision. mm.
Objective 0	4	235	265	32
	5	216	247	25
	8	115	193	20
	10	100	218	15
	15	83	240	11
Objective 1	15	13	65	—
	20	12	88	—
	25	11	112	8.5
	30	11	133	—
	40	11	170	—
	50	10	200	—
	60	10	230	3
	70	10	260	—

The lower objective is screwed into the upper, and the higher objective into the lower side of the carrier. For a magnification of four diameters it is necessary to place the object-table 20 mm. below its upper limit. In order to avail one's self of the whole field of vision with an enlargement of only four or five diameters, it is necessary to unscrew the object-table from its ring, and to use the latter alone as table. Having placed the objective and the camera in the positions required for a given magnification, the focal adjustment is effected by moving the object-table.

Ryder's Automatic Microtome.—This new instrument has been devised by Professor John A. Ryder, of the Biological Department of the University of Pennsylvania, in order to facilitate the preparation of sections for large classes, and also for the rapid preparation of series of sections in ribbons in embryological work, in which the element of time becomes a serious consideration. The device is small and compact and is also automatic,—that is, the same movement which cuts the section also brings the block into position for cutting the next successive section, and so on continuously, of any desired uniform thickness; the cutting takes

place as fast as it is possible to move a vibrating lever up and down through a distance of three inches with the right hand. Nearly all other automatic microtomes are costly, unwieldy, large and heavy, or else very complicated and liable to get out of order. The only exception in part to this rule is the Rocking Microtome, made in Cambridge, England; but it cuts in an arc, so that the sections are segments of a hollow cylinder, and not parts of a perfect plane; besides, the rocking or vibrating arm admits of only a very limited movement, so that the instrument is suitable only for cutting sections of objects of very limited dimensions; nor is the position of the block adjustable. Moreover, in none of the automatic microtomes now in use is it possible to place the knife at right angles or any other desired angle to the direc-



tion in which the block to be cut is moved,—a great desideratum in botanical or other work in which an inclined knife is necessary. In order to supply an instrument serviceable especially to teachers, as well as to all classes of students, botanists, pathologists, histologists, and zoologists, the designer has attempted to bring together all the desirable features of previously invented instruments, in as simple, convenient, and compact a form as possible, without sacrificing rapidity and efficiency of action.

The working parts are an oscillating lever, which is provided with a clamp at one end into which the paraffine-holders are adjusted, and at the other with a simple handle. This lever rests upon trunnions on either side, and these in turn rest in triangular notches at the top of the two pillars between which the lever

oscillates. At the cutting end of the lever a spring pulls the lever down and effects the sectioning and also the adjustment for the next section. The lever is pushed over and adjusted for the successive sections by a hollow screw, through which passes the trunnion on the side away from the knife. This screw is fixed to a toothed wheel, three inches in diameter, which revolves close by the side of the oscillating lever. The toothed wheel and screw is actuated by a pawl fixed to the side of the lever near the handle. The number of teeth which this pawl can pass in a single vibration downward is controlled by a fixed stop screwed into the under side of the oscillating lever near the handle; the end of this stop striking on the top of the bed-plate thus brings the lever to rest at a constant point in its downward excursion. An adjustable sector by the side of the toothed wheel throws the pawl out of gear after a given radius of the wheel has been turned through an arc embracing the desired number of teeth. This adjustment is also effected before the block, containing the object to be cut, reaches the edge of the knife. The adjustment for the next section is therefore effected while the surface of the block is not in contact with the under side of the knife, so that no flattening or scraping effect is produced on the surface of the block in its upward passage past the knife.

The movement of the vibrating lever being arrested at each down stroke at one point and the pawl which catches into the notches in the toothed wheel being released at any desired point by the action of the adjustable sector, it is possible to adjust the apparatus with great accuracy for cutting sections of any desired thickness. If a given radius of the wheel is moved through the arc embraced by a single tooth, sections are cut having a thickness of only $\frac{1}{10000}$ of an inch, or .0025 mm.,—a thickness which is only practically possible with paraffine embedding and a very keen razor. If more teeth are taken by the pawl, any thickness of section is possible up to about $\frac{1}{400}$ of an inch, or .0625 mm.[1]

A freezing attachment which has lately been appended to the apparatus shows that frozen sections can be made with as great rapidity and success as those cut from objects embedded in the paraffine block, and very nearly, if not quite, as thin. The freezing attachment is as simple and efficient as the self-adjusting and cutting devices of the instrument. Other auxiliary apparatus makes it possible to cut celloidin sections. This is effected by means of alcohol conducted by a tube from a reservoir to the knife, over which the fluid will run and drain into a tray below in such a way as not to come in contact with any other parts of the machine. This tray fits into a recess in the side of the bed-

[1] The screw which adjusts the block for cutting has exactly fifty threads to the inch, and there are two hundred teeth on the periphery of the toothed wheel. The value of a single tooth is, therefore, $\frac{1}{50} \times \frac{1}{200} = \frac{1}{10000}$ inch.

plate of the instrument just below the knife, and into this tray the celloidin sections may be allowed to drop as fast as cut.

The paraffine-holders are square and seven-eighths of an inch in diameter, so that a block of that size may very readily be sectioned. For the botanist, one of these holders is provided with a movable side and screw for clamping objects, so that rather tough stems may be firmly held between blocks of cork, while the more delicate vegetable tissues, or such as must be embedded in fresh carrot, soaked in gum and hardened in alcohol, may also be firmly held for sectioning by the same device, provided the pieces of carrot are first trimmed into the right shape. The same style of holder is equally applicable for holding the corks—if properly trimmed—upon which tissues are embedded in celloidin or in gum. This style of holder also enables one to embed very long objects entire in paraffine,—such as earth-worms,—and to cut them as a single piece, provided the surrounding paraffine is carefully trimmed so as to have two opposite sides parallel. An object six inches long and three-fourths of an inch in diameter embedded in this way may be cut into an absolutely continuous series of sections without losing any essential portions. This is accomplished by slipping the block through the quadrangular clamp for the distance of half an inch every time a half-inch of the object has been cut off in the form of sections. One-half inch is the length of block which can be cut at one time without readjusting the feed-screw which moves the block and vibrating lever over towards the knife, the whole being kept firmly in place against the face of the hollow screw by a strong spring which presses against the end of the trunnion on the outside of the iron pillar on that side of the instrument where the knife is fastened, so that all the sections are of exactly the same thickness from first to last. Cutting up large objects in the manner above described is not possible with any other form of microtome yet constructed.

Almost any section-knife—wide- or narrow-bladed—will fit into and be firmly held by the knife-clamp, which is, however, intended more especially to hold an ordinary razor. The best razors for cutting sections have been found to be those of the best make only, such as Wade & Butcher, or Joseph Rodgers & Sons, of Sheffield. Only such razors as hold an edge well should be used.

For ribbon-cutting by the paraffine method the block containing the object, after it is trimmed and soldered to the paraffine with which the holder is filled, by means of a heated wire, is covered with a thin coat of soft paraffine or "paraffine-gum," and of which "chewing-gum"[1] is made. This enables one to cut

[1] Chewing-gum may be rendered available for this purpose if it is melted at a temperature somewhat above boiling, when the sugar which it contains will separate as caramel, leaving the pure paraffine-gum, which may be drained off and used as

ribbons of any desired length, since the softer paraffine at the edges of the successive sections sticks them together by their margins as fast as they are cut.

The ribbons may be allowed to fall upon a slip of paper, which may be drawn out, as fast as the sections are cut, from under the bed-plate of the instrument, beneath which there is a space left for this purpose between the three toes or tripod upon which whole apparatus rests. The edge of the knife also remains in the same plane, no matter at what angle the cutting edge is placed with reference to the direction in which the block to be cut is moved, just as in the best forms of the sledge microtome.

The advantages which this new instrument offers are, briefly, comparatively small cost, great efficiency, rapidity, and accuracy. One hundred sections per minute may very readily be cut with it. Its simplicity of construction, with few wearing parts, and slight liability to get out of order in the hands of inexperienced persons, will also commend it to the teacher and investigator. Experience has already shown that those once using it can scarcely ever be again induced to use the most efficient sledge or automatic microtomes of different design if they can have access to this instrument. This device is made by Mr. Zentmayer, whose name is a sufficient guarantee of the workmanship employed in its construction.

SCIENTIFIC NEWS.

—William Willoughby Cole, the Earl of Enniskillen, who died November 12, 1886, was the possessor of one of the largest collections of fossil fishes in existence. He was associated with Sir Philip Grey Egerton in preparing the catalogue of fossil fishes so useful to geologists.

—Henry Woodward, of the British Museum, is preparing a third edition of Morris's "Catalogue of British Fossils," to be issued by the Cambridge University Press this year.

—C. E. Broome, an English mycologist, died at Bath, England, November 15, 1886.

—Karl Goebel, professor of botany at Rostock, is called to Marburg to take the chair left vacant by the death of Professor Wigand.

—Culver Hall, at Dartmouth College, caught fire, Sunday, February 20, and the geological and zoological collections of the college had a narrow escape from destruction.

directed, if the manipulator should find it difficult to get the paraffine-gum of commerce.

—Dr. Martin Websky, professor of mineralogy in the University of Berlin, died November 27, 1886, aged sixty-two years.

—Thomas H. Dodge has given the Worcester Lyceum and Natural History Association one thousand dollars to buy tents and build a pavilion for the summer classes managed by the association at Lake Quinsigamond.

—Dr. R. W. Shufeldt has issued a catalogue of his various scientific papers and shorter notes. It embraces one hundred and three titles of articles already published, besides several more in press or well under way.

—Professor Ernst Haeckel, of Jena, goes this year to the Mediterranean to continue his studies.

—The lectures given by Sir J. W. Dawson during the past winter, before the Lowell Institute, in Boston, are to become the basis of a volume in the "International Scientific Series." The subject is the development of plants in geological time.

—January 15 Professor Hermann Burmeister, the entomologist and palæontologist, completed his eightieth year. Since 1871 he has been settled in Buenos Ayres, and has done much towards the working up of the fauna of the Pampas formations. The University of Buenos Ayres has recently conferred upon him, as well as upon Carl Berg, professor of botany and zoology in the University, the degree of Doctor of Physical Sciences, in recognition of their labors.

—R. Friedländer and Sohn, of Berlin, have begun the publication of another help for students of natural history. It is entitled *Societatum Litteræ*, and aims to give, in the briefest shape, a catalogue of all articles relating to natural sciences published in the transactions of learned societies in all parts of the world. The first number contains eight pages, and indexes thirty journals. The numbers will appear monthly, and are sent post-free for the nominal sum of two and one-half marks. It is edited by Dr. Ernst Huth, of Frankfurt a. O. From its more limited field, it will not take the place of the well-known bibliographic lists in the *Zoologischer Anzeiger*.

—Mr. Alexander Agassiz was honored with the degree of Doctor of Science by the University of Cambridge during his recent visit to England.

—There were fifty-two different contributors to the first volume of the AMERICAN NATURALIST, twenty years ago. Of these at least thirty-four are alive at the time of writing. Are scientific studies conducive to longevity?

—Thomas Moore, the superintendent of the Botanic Gardens at Chelsea, London, died on the first day of this year. He was well known among botanists.

—L. Ranvier, the well-known histologist of Paris, has been

elected a member of the Academy of Sciences in the place of Charles Robin.

—F. L. Cornet, who has been a special student of the Cretaceous and Tertiary formations of Belgium, died at Mons on the 20th of January, aged fifty-two years.

—Dr. K. Oebbecke, of Munich, is called to the chair of Mineralogy and Geology at the University of Erlangen.

—In the recent death of Professor Edward L. Youmans science has lost a most untiring advocate and disseminator. The value of such men to the intellectual life of a country cannot be estimated. As editor of the *Popular Science Monthly Magazine* Professor Youmans brought before the American public in popular form the latest results of the scientific work of Europe, besides giving currency to much interesting matter which lies on the borderlands of science, and in the field of applied science and of art. Professor Youmans was born in Albany County, New York, in circumstances which required energetic effort to enable him to gratify his natural taste for knowledge. During his life he was harassed by a disease of the eyes, which also rendered his labors more difficult. But in spite of these obstacles his success in his chosen field of instructor and disseminator of positive knowledge, was probably greater than that of any other American.

—We much regret to have to notice the suspension of the German scientific periodical, *Kosmos*, a high-class journal conducted with much ability.

PROCEEDINGS OF SCIENTIFIC SOCIETIES.

Boston Society of Natural History.—March 2.—Mr. C. D. Walcott described a trip to the Grand Cañon of Colorado (illustrated by the stereopticon), and Mr. J. H. Emerton showed parts of a restoration of a skeleton of Uintatherium and described the method of making paper models.

New York Academy of Sciences.—January 17.—The following paper was read: "On an Iron Meteorite that fell at Mazapil, Mexico, during the display of 'Bielid' meteors, November 27, 1885, with an account of its fall by Professor José A. y Bonilla, Director of the Zacatecas Observatory" (with exhibition of the specimen), by Mr. Wm. Earl Hidden.

January 10.—The regular business meeting was held, and the question of raising the annual dues to ten dollars was discussed. The following paper was read: "Notes on the Growth of a Vinegar-plant in Fermented Grape-juice" (with specimens), by Dr. N. L. Britton.

Monday evening, March 7.—H. L. Fairchild addressed the academy upon "Transformations of the Skin in the Animal Kingdom."

Biological Society of Washington.—March 5.—The following communications were made: P. L. Jouy, "Corea: the Country and the People." Prof. Frank Baker, "Notes on some Unusual Muscular Variations." Dr. T. H. Bean, "European and American Work in Deep-Sea Ichthyology." Dr. C. Hart Merriam, "Contributions to North American Mammalogy. Description of New Species of *Evotomys*." Dr. H. G. Beyer, "Remarks on the Preservation of Bottled Museum Specimens."

Appalachian Mountain Club.—Tuesday evening, March 1.—Mr. C. D. Walcott, Assistant U. S. Geological Survey, presented a paper entitled "A Trip to the Grand Cañon of the Colorado," illustrated by the stereopticon.

Kent Scientific Institute of Grand Rapids, Kent County, Michigan.—The following are the officers for 1887: President, E. S. Holmes; Vice-President, W. A. Greeson; Secretary, C. A. Whittemore; Treasurer, S. L. Fuller; Corresponding Secretary, E. S. Holmes; Director of Museum, W. A. Greeson; Curator, E. L. Moseley; Librarian, E. L. Moseley.

Sedalia Natural History Society.—November 8, 1886.—Professor G. C. Broadhead, formerly State Geologist of Missouri, read a paper on the "Geology of Western Missouri."

December 13.—Mr. H. M. Specking spoke on the "Study of Natural History and the Use of the Microscope."

January 10, 1887.—F. A. Sampson exhibited a fine skull of the *Coryphodon* from the Bad Lands of Dakota, and described it; Mrs. C. Demuth read a paper on "Reptiles." The following were elected officers for 1887: President, Dr. J. W. Trader; Vice-President, H. C. Sinnett; Corresponding Secretary, F. A. Sampson; Recording Secretary, J. W. Walker.